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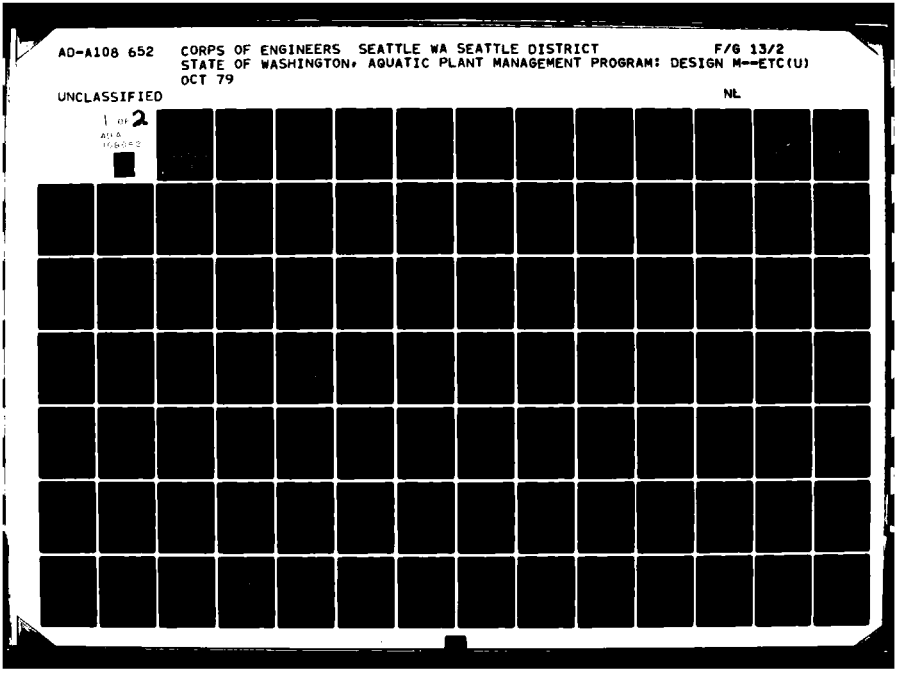

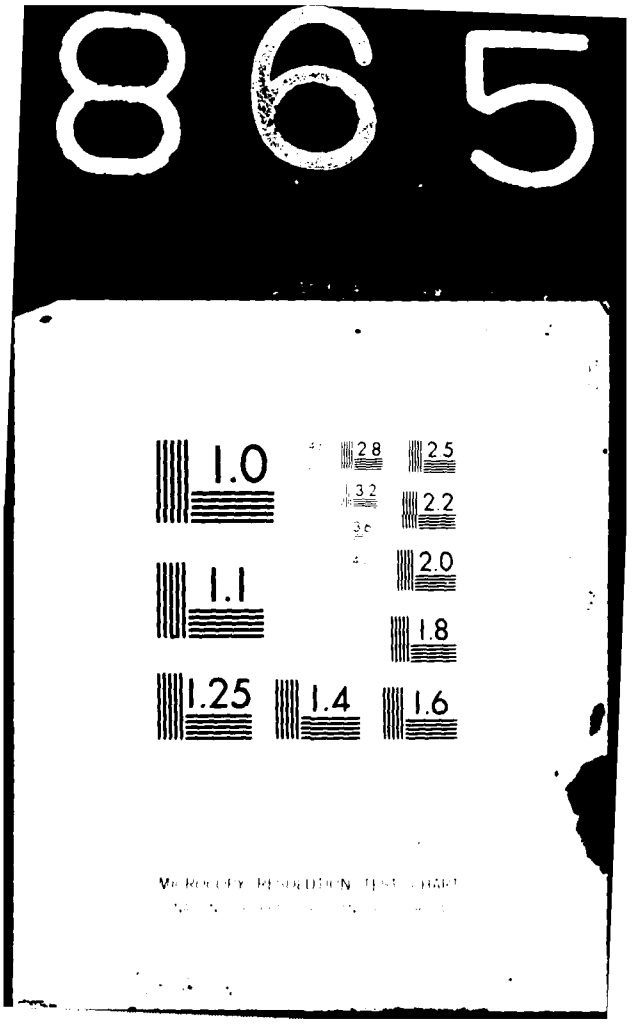
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STATE OF WASHINGTON

aquatic plant management program

DESIGN MEMORANDUM

SEATTLE DISTRICT
U.S. ARMY CORPS OF ENGINEERS

OCTOBER 1979

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
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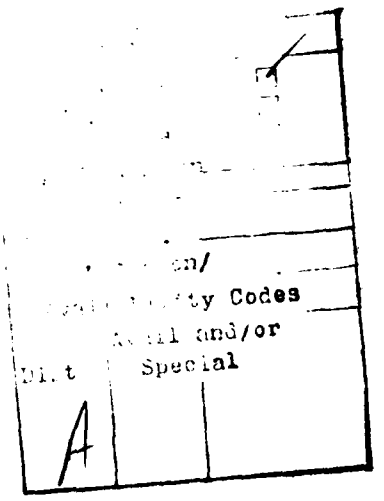
Aquatic plants; management; Washington (State); Eurasian watermilfoil

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This design memorandum recommends a plan for the control of Eurasian watermilfoil, a nonnative aquatic plant, in the waters of Washington State. The plan was developed in response to a request from the State of Washington. Milfoil is presently a problem in several lakes, rivers, and reservoirs in eastern Washington and the Puget Sound area in western Washington. It has curtailed recreation activities in these areas and has the potential of decreasing water quality and impacting hydropower production, fish and wildlife,

irrigated agriculture, and public health. In 1978, there were approximately 1,500 acres of navigable and nonnavigable waters with milfoil growth throughout the state. It is estimated that 113,000 acres of navigable waters could become infested within the next 15 years. The recommended plan consists of methods of prevention and control outlined in the report.



SYNOPSIS

This design memorandum recommends a plan for the control of Eurasian watermilfoil, a nonnative aquatic plant, in the waters of Washington State. The plan was developed in response to a request from the State of Washington.

Milfoil is presently a problem in several lakes, rivers, and reservoirs in eastern Washington and the Puget Sound area in western Washington. It has curtailed recreation activities in these areas and has the potential of decreasing water quality and impacting hydropower production, fish and wildlife, irrigated agriculture, and public health. In 1978, there were approximately 1,500 acres of navigable and nonnavigable waters with milfoil growth throughout the state. It is estimated that 113,000 acres of navigable waters could become infested within the next 15 years.

The recommended plan consists of:

- Prevention. The prevention program addresses water bodies where the detection and treatment of milfoil will prevent its spread to navigable waters within the state. The estimated first year cost of the prevention program is $200,000. Acceptable treatment methods include rotovating, suction dredging, hand removal, spot herbicide 2,4-D application, and fragment barriers.

- Control. The first year control program is designed to reduce milfoil growth in approximately 100 acres of Lakes Washington, Union, and Sammamish in western Washington where it is obstructing recreational use. The estimated cost is $76,000 if the herbicide 2,4-D is used (low cost alternative) or $192,000 if mechanical harvesting and fiberglass bottom screens are used (high cost alternative). Acceptable treatment methods include mechanical harvesting; fiberglass bottom screens; and the herbicides 2,4-D, diquat, endothall (dipotassium salt), or dichlobenil.

The non-Federal cost share is 30 percent and the Federal share is 70 percent. A cooperative agreement between the Corps of Engineers and the State of Washington will implement the program. The Washington State Department of Ecology has the option of entering into agreements with local governments or doing the work themselves. Selection of a treatment method for individual sites will be the responsibility of the local sponsor.

First year costs for the prevention and control programs, including aquatic plant community and water chemistry monitoring and program evaluation, are estimated to be $276,000 (low cost) or $392,000 (high cost). Benefits are estimated to be $1,397,000. The benefit-to-cost ratio is 5.1 to 1 for the lowest cost (chemical) alternative and 3.6 to 1 for the highest cost (mechanical) alternative.

The aquatic plant management program will be reviewed annually. Changes to the program will be incorporated in an annual supplement to this design memorandum, with state and local government providing input to accurately reflect current conditions.

Rev. Feb. 1980

ERRATA SHEET

page 3-5 Table 3-2 Alternative Treatment Methods

To the regulatory requirements for 2,4-D (DMA & BEE)), endothall, diquat, and dichlobenil add the statement, "May require Department of the Army permit."

The regulatory requirements for harvesters and hand removal should be corrected to say, "May require Department of the Army permit."

The regulatory requirements for rotovators and suction dredge should be corrected to say, "Would require Department of the Army permit due to the alteration of the bottom."

STATE OF WASHINGTON
AQUATIC PLANT MANAGEMENT PROGRAM
DESIGN MEMORANDUM

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FINAL ENVIRONMENTAL IMPACT STATEMENT
(Bound separately)

SECTION 1. INTRODUCTION

1.01 Authority. This design memorandum was prepared in accordance with Engineering Regulation 1130-2-412, Project Operation, Aquatic Plant Control Program, RCS-DAEN-CWO-51, dated 28 May 1976, under authority of Section 302 of the River and Harbors Act of 1965 (Public Law 89-298). Federal interest within the authority of this program extends to those water bodies which are navigable[1/] and those nonnavigable water bodies where Eurasian watermilfoil has the potential for spreading to navigable waters. Existing Federal project areas cannot be included as part of any management program developed under this authority. These areas may be addressed under the projects operation and maintenance program.

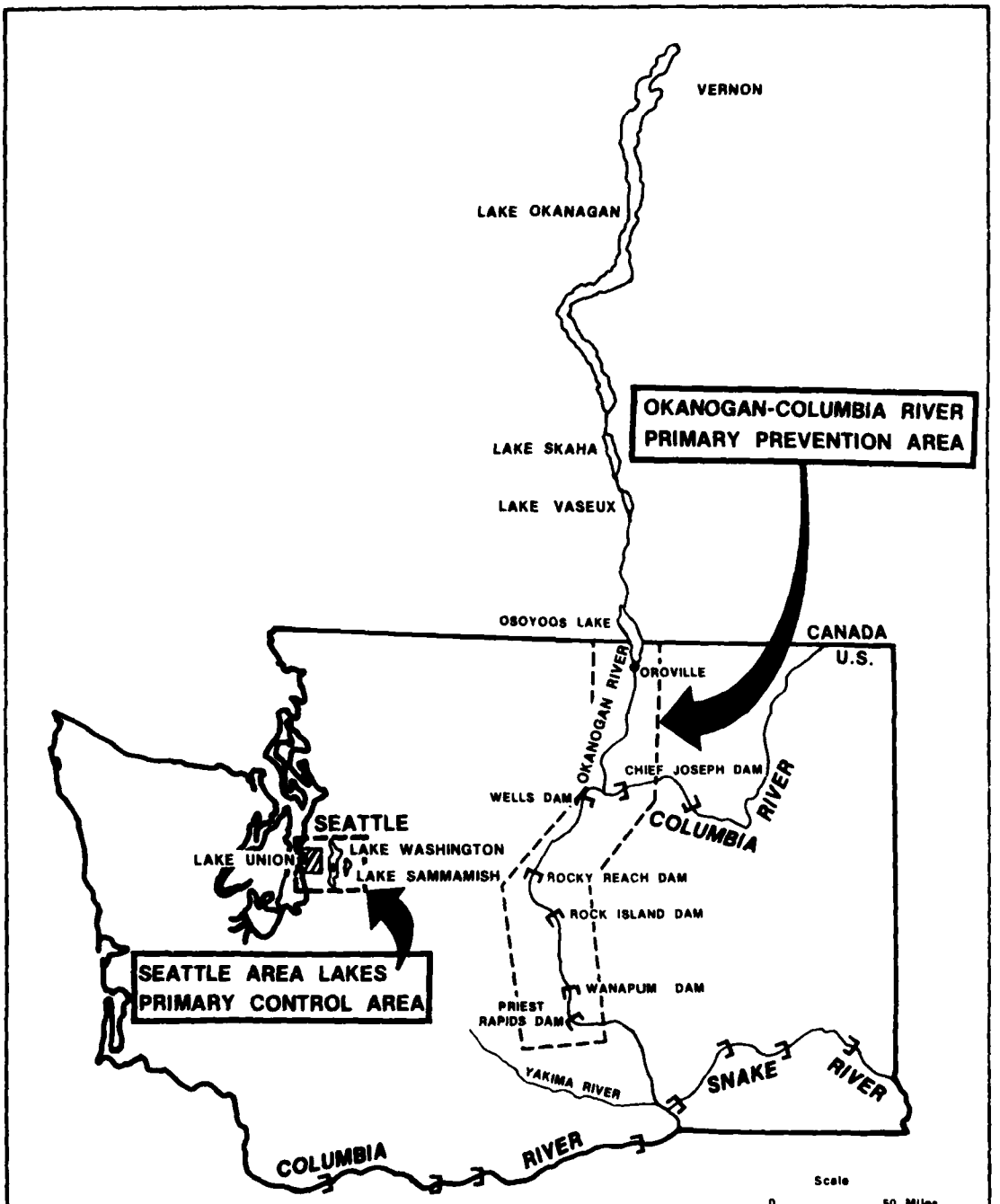
1.02 Scope of Study. This design memorandum presents the results of studies of Eurasian watermilfoil (Myriophyllum spicatum L.), hereafter referred to as milfoil, a nonnative aquatic plant found in the waters of Washington State, and the development of alternatives for controlling its growth and preventing its spread to navigable water. Technical data were developed through field investigations, recreational and property value analyses, inventory of environmental base conditions and assessment of program impacts, fish and wildlife studies, detailed site analyses, and from other aquatic plant management programs in the United States and Canada.

1.03 Location and Extent of Project Area. The project area is the State of Washington (see figure 1-1). Milfoil has been identified in 14 lakes and 1 river in western Washington (see figure 1-2). These water bodies contain about 900 acres of milfoil. In eastern Washington there are several U.S. Bureau of Reclamation reservoirs, Osoyoos Lake, and the Okanogan River where milfoil has been identified (see figure 1-3). There are about 600 acres of milfoil in these water bodies.

1.04 Corps of Engineers Studies.

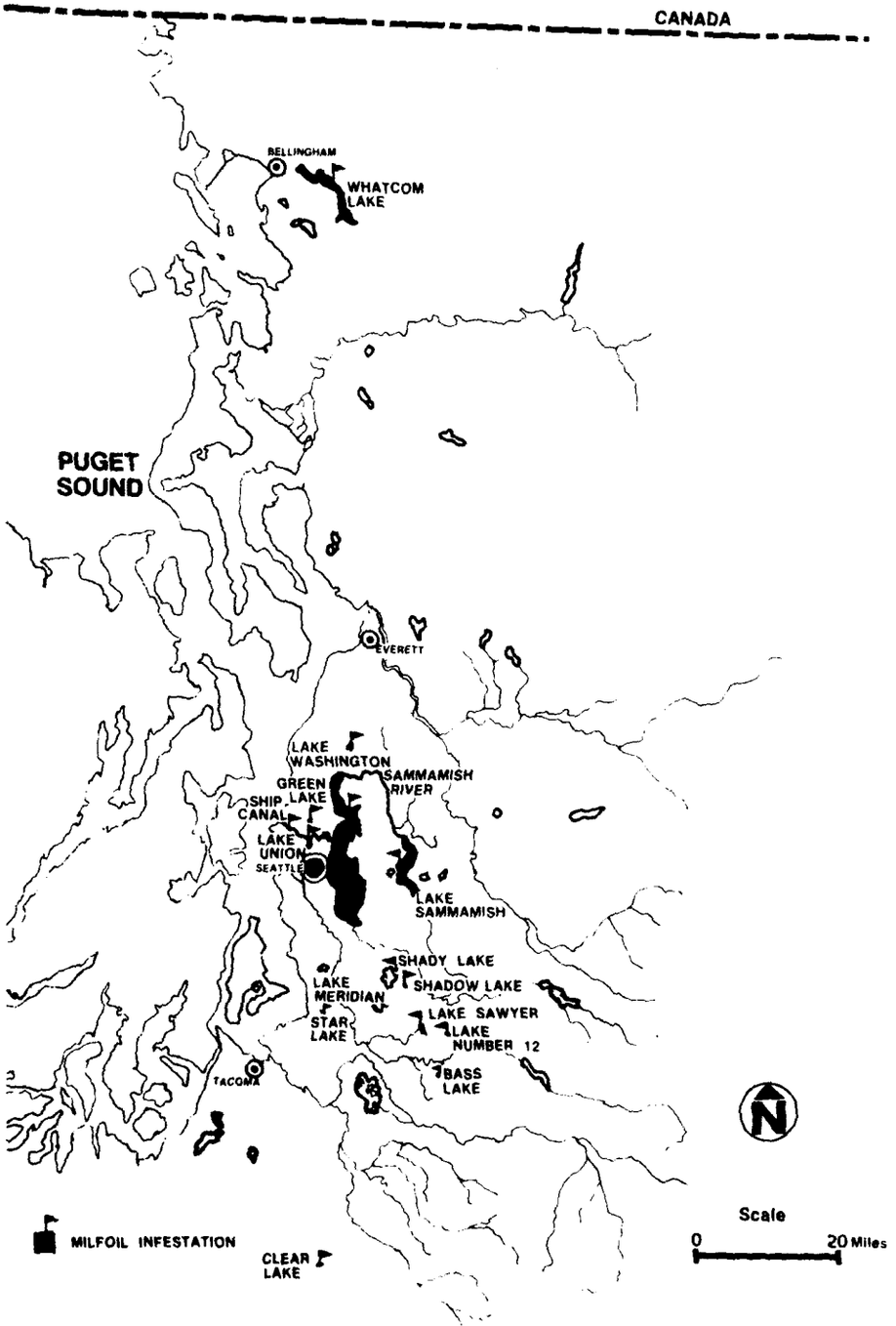
a. Aquatic Plant Management Reconnaissance Report. This report, completed in August 1977, determined that there was a Federal interest in milfoil growth in Washington State and that detailed studies should be made of its effects upon navigation, recreation, hydropower, irrigated agriculture, flood control, and related purposes. The report set a schedule for more detailed studies, established the Federal/state cost-sharing requirements, and verified the intention of Washington State Department of Ecology (WDE) to provide sponsorship of a program. The reconnaissance study involved coordination with a wide range of Federal, state, and local agencies and groups.

1/ "Navigable" means those waters of Washington State which are navigable for the purposes of commerce.



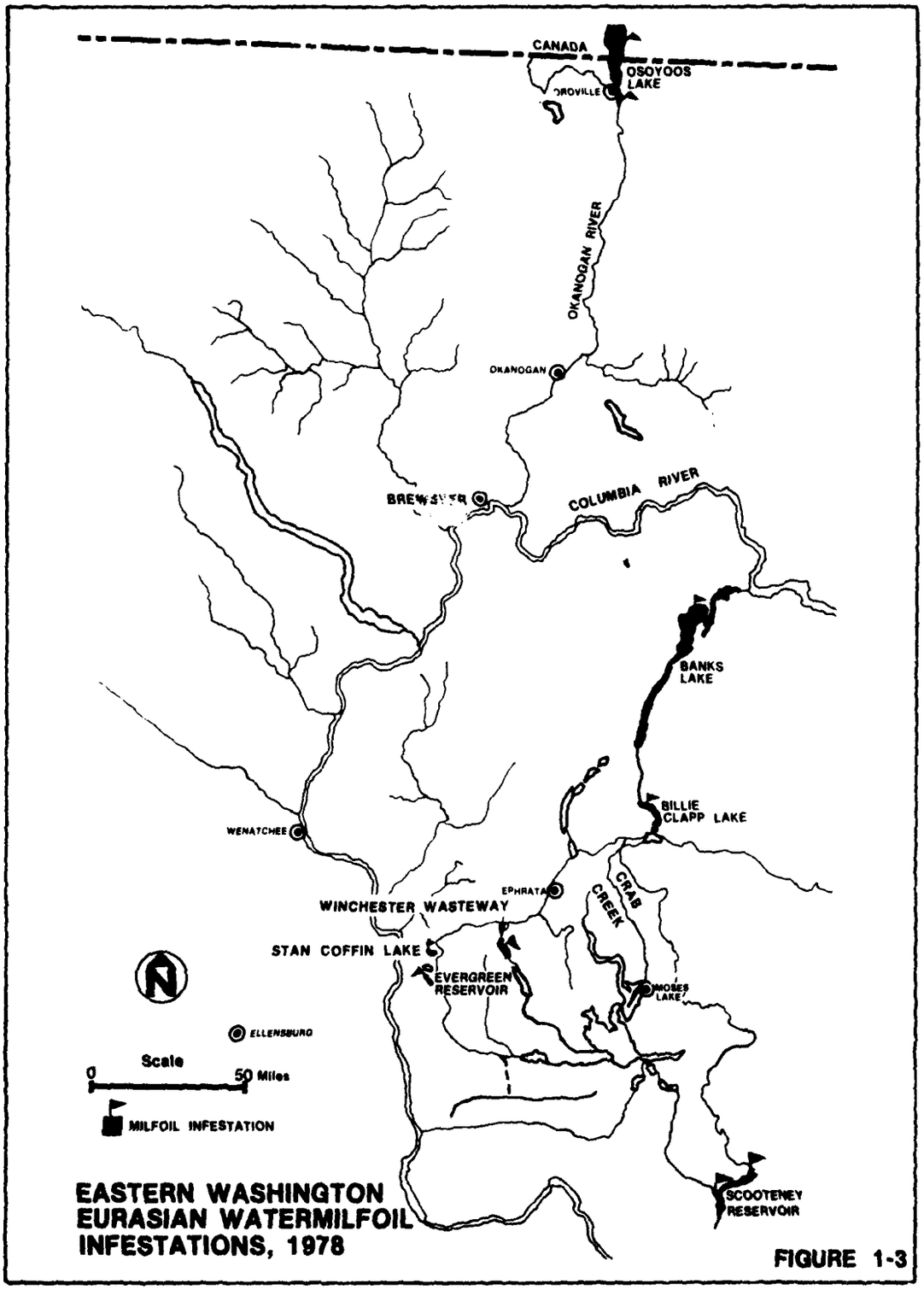
STATE OF WASHINGTON
AQUATIC PLANT MANAGEMENT PROGRAM PROJECT AREAS

FIGURE 1-1



WESTERN WASHINGTON EURASIAN WATERMILFOIL INFESTATIONS, 1978

FIGURE 1-2


CANADA
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OKANOGAN RIVER
OKANOGAN
COLUMBIA RIVER
BANKS LAKE
BILLIE CLAPP LAKE
WENATCHEE
EPHRATA
CRAB CREEK
WINCHESTER WASTEWAY
STAN COFFIN LAKE
EVERGREEN RESERVOIR
MOSES LAKE
ELLENSBURG
Scale
0
50 Miles
MILFOIL INFESTATION
SCOOTENEY RESERVOIR
EASTERN WASHINGTON
EURASIAN WATERMILFOIL
INFESTATIONS, 1978

FIGURE 1-3

b. Waterways Experiment Station (WES) Studies.

(1) Strawman Aquatic Plant Management Plan. To assist the Seattle District in the aquatic plant management study, WES, in 1978, prepared the Strawman Report. This draws on Corps experience in aquatic plant control and outlines recommendations for prevention and control programs. It also contains an extensive list of alternatives.

(2) Large Scale Operations Management Test (LSOMT). In 1979, WES initiated the LSOMT, a 3-year study to evaluate the concept of prevention as an operational technique for the management of aquatic plants. The LSOMT estimated the potential for milfoil infestations in navigable waters of Washington State and will test the effectiveness of several prevention strategies. The results of this work will be made available to interested individuals, groups, and agencies and used to increase the effectiveness of on-going programs.

1.05 Other Studies.

a. The Municipality of Metropolitan Seattle (METRO). Under the auspices of the city of Seattle and King County, METRO conducted an aquatic plant study in 1976 and identified milfoil in about one quarter of the 24 King County lakes it inventoried. The largest single infestation (about 200 acres) was found in Union Bay, Lake Washington.

Prompted by citizen concerns, METRO developed a milfoil control demonstration project, in Union Bay, to investigate different milfoil control methods, primarily mechanical harvesting and fiberglass screens. The demonstration project has been underway since late 1977 and is being conducted in cooperation with WDE and the University of Washington.

b. British Columbia. In 1970, a small colony of milfoil was discovered near Vernon, British Columbia, on Lake Okanagan.[1/] At first, the plant was thought to be a native species whose growth rate had somehow gone wild. It later was recognized as Eurasian watermilfoil, and research, experimentation, and testing of control methods (primarily mechanical methods) were initiated by the British Columbia Government. However, milfoil continued to spread downstream. A 20-foot-diameter patch of the weed found in Lake Vaseux in 1975 became a 20-acre patch covering 19 percent of the littoral area of the lake by 1976. Milfoil was discovered in 1976 in the next lake downstream, *Osoyoos Lake* (*half this lake is in Canada, half in the United States*). It infested only the Canadian (northern) end of the lake in 1976; however, colonies were found in the United States end of the lake in 1977. The Canadians have experimented with a wide range of mechanical control methods such as hand removal, rotovating, mowing, and suction dredging. They have also constructed several boom and screen structures across the Okanagan River to impede the downstream

1/ Okanagan is the the Canadian spelling.

movement of plant fragments. Each barrier is estimated to be 80 to 90 percent effective. Even with these efforts, however, the growth of the plant has continued to follow an exponential rate. The use of the herbicide 2,4-D is now being used on an experimental basis. The yearly cost of the Canadian Okanagan aquatic plant management program has risen to over $1.5 million.

c. Tennessee Valley Authority (TVA). There was a 2-acre patch of milfoil in the TVA system in 1959. By 1969, it had spread to cover 25,000 acres in seven TVA system reservoirs. Its spread down the Tennessee River was enhanced by wind and boating activities. TVA conducted research and experiments in the mid-1960's and in 1969 initiated a major control program. The level of infestation has been reduced from 25,000 acres to under 4,000 acres. A maintenance program, including yearly 2,4-D applications, continues; however, water level fluctuation has become the most important control method used for milfoil control on the reservoir system.

d. Washington State Department of Ecology. In coordination with Seattle District, WDE initiated a limited control program in Osoyoos Lake and the Okanogan River. The 1979 WDE program includes:

- contracting with Okanogan County to manage local control efforts and handle public information efforts in the Okanogan Valley area;

- aquatic plant surveys of Osoyoos Lake;

- hand removal of, or 2,4-D application to, small colonies of milfoil identified in Osoyoos Lake; and

- operation of a plant fragment collection barrier and screen across the Okanogan River, downstream of Osoyoos Lake.

1.06. Coordination. Details of coordination, sponsorship letters, and public involvement appear in appendix C. Extensive coordination with the public and Federal, state, and local government agencies was accomplished through two public meetings (4 September 1979 and 6 September 1979), four public workshops (12 July 1977, 14 July 1977, 25 January 1979, and 30 January 1979), one public brochure containing a comment sheet to be returned to the Corps by interested and concerned individuals (August 1979), and one information pamphlet containing a questionnaire (January 1979). Initial coordination efforts were directed toward informing potential participants of the study, soliciting information on alternatives, obtaining information on specific problem areas, and establishing a framework for future coordination. Later coordination efforts were directed toward analyzing the final array of alternatives.

1.07 A major concern expressed by those in attendance at the public workshops in January 1979 and the public meetings in September 1979 was the need for prompt action in managing milfoil growth. Another concern expressed from a public health standpoint related to the use of chemicals for controlling milfoil. Most of the respondents to the questionnaire contained in the January 1979 information pamphlet indicated that milfoil infestation was a problem and about one-half of the respondents favored chemical treatment as the most effective method of control. Most of the comments received from the August 1979 public brochure were in favor of the proposed aquatic plant management program.

1.08 Coordination of the Draft Environmental Impact Statement (EIS). The draft EIS was listed in the Federal Register on 27 July 1979. The comment period for the draft EIS was extended to 14 September 1979 at the request of the U.S. Department of Interior. The comment period for the 4 and 6 September public meetings also ended on 14 September 1979. Major areas of concern raised by the public and agency review of the draft EIS included the impacts of the application of 2,4-D on fish, wildlife, and humans; the adequacy of the data used as the basis of establishing an aquatic plant management program; the impacts of decaying milfoil resulting from the use of 2,4-D for milfoil control; reservations concerning the need for an aquatic plant management program because of the belief that milfoil does not possess sufficient detrimental characteristics nor have sufficient detrimental effects; and reservations concerning the adequacy of evidence indicating that milfoil will spread without prevention and control measures. There were also requests to add additional beach areas as part of the program. Comments were addressed by additional agency coordination, literature research, and by additions to the proposed program consisting of aquatic plant community and water quality monitoring and program evaluation and prioritization of areas proposed for treatment. Responses to all comments are provided in chapter 9 of the final EIS.

SECTION 2. PROBLEMS AND NEEDS

2.01 Existing Conditions. Surveys of milfoil growth in the State of Washington were conducted in 1978 by WDE and by METRO in King County. Water bodies identified by these surveys are shown on figures 1-2 and 1-3. The approximate number of infested acres is summarized below:

Water Body	Acres of Milfoil Growth	
Seattle Metropolitan Area		
Ship Canal	8	
Lake Washington	450	
Lake Union[1/]	45	
Lake Sammamish	250	
Green Lake	trace	
Sammamish River[2/]	-	
Subtotal		753
King County		
Lake Meridian	27	
Lake Sawyer	60	
Shadow Lake	7	
Shady Lake	1	
Lake Number Twelve	22	
Star Lake	7	
Bass Lake	trace	
Subtotal		124
Other Lakes - Western Washington		
Clear Lake [2/]	-	
Lake Whatcom	50	
Subtotal		50
Eastern Washington Lakes		
Osoyoos Lake	1	
Banks Lake	500	
Billie Clapp Reservoir	5	
Evergreen Reservoir	100	
Scooteney Reservoir	2	
Okanogan River [2/]	-	
Stan Coffin Lake [3/]	-	
Winchester Waterway [3/]	-	
Subtotal		608
Total		1,535

1/Acreage estimate is based on an August 1979 METRO survey of Portage Bay.

2/No estimates of infested acres available.

3/Information was provided by the Bureau of Reclamation. No estimates of infested acres available.

These areas include several state and local parks and swimming beaches, as well as public waters adjacent to private property.

2.02 Potential for Milfoil Growth. Using measurements of light penetration, water quality, and sediment characteristics, a field team from WES made the following projections of potential maximum milfoil growth in selected water bodies:

Water Body	Potential Acres of Milfoil Growth
Lake Washington	3,930
Lake Union	180
Lake Sammamish	690
Osoyoos Lake	550
Okanogan River	440
Columbia River	106,750
Total	112,540

2.03 Impacts of Milfoil Growth.

a. Fish and Wildlife. The Fish and Wildlife Service offers the following summary of what is known or suspected about the effects of milfoil upon fish and wildlife resources:1/

- Milfoil has some value to waterfowl and, when regulated by natural or man-initiated means, it grows in a mixed macrophyte community that affords a food source for Canada geese, widgeon, and possibly for gadwalls, scaups, and pintails.

- When milfoil infestations become excessive, choking out other aquatic species, their total value to waterfowl is usually reduced. However, there is no current evidence to show that milfoil, at any level, is detrimental to waterfowl.

- Moderate growths of milfoil support and enhance increased populations of spiny-ray fish species. As the infestation increases, however, creating a milfoil monoculture, the border effect2/ is lost, the benthic invertebrate population is reduced or replaced by epiphytic invertebrates, and the overall spiny-ray fish values are reduced.

1/U.S. Fish and Wildlife Service, Planning Aid Letter to Seattle District, Corps of Engineers, 18 December 1978, and draft report of the U.S. Fish and Wildlife Service on Seattle District, Corps of Engineers, Aquatic Plant Management Program, 2 July 1979 (see appendix D).

2/Border effect is the name given to increased feeding area for fish along the edges or borders of submergent aquatic vegetation, which results in increased game fish populations. The shelter is furnished by the vegetation, and the food by the invertebrate population which it supports.

- Some milfoil infestations, with their attendant spiny-ray populations at the mouths of anadromous fish streams, could create predatory impacts on migrating juvenile salmon.

- Because of its tenacious rooting system, there is speculation, but no documentation, that milfoil could invade traditional salmon spawning sites.

b. Recreation. Heavy growths of milfoil obstruct swimming, boating, sailing, water-skiing, and sports fishing. Recreational activities on the shores of water bodies are made less appealing due to infestations because of the displeasing characteristics of decaying milfoil and the increase in mosquito breeding areas in milfoil mats. Public safety is endangered through the increased possibility of boating, swimming, and water-skiing accidents, which could be caused by collision with floating milfoil mats or entanglement with rooted plants.

c. Navigation. Commercial navigation is largely unimpeded by infestations of milfoil, since it does not grow in the deeper waters through which larger vessels navigate. However, smaller vessels and recreational boats passing through shallow waters, such as the freshwater lakes in the vicinity of Seattle, have experienced problems with the fouling of propellers and rudders and the clogging of cooling water intakes.

d. Hydropower. Milfoil is fragmented by recreational activities, wave action, and natural dieback. Heavy infestations could result in large mats of fragments floating downstream and clogging water intake systems or trash racks for hydropower projects, thus increasing maintenance costs.

e. Irrigation. Irrigation works could be particularly vulnerable to severe problems from heavy infestations of milfoil. Such growths can greatly reduce the flow of water through distribution canals and laterals because of the hydraulic resistance created. Most irrigation systems in the western United States already experience problems associated with the growth of various other aquatic plants. However, milfoil's ability to rapidly colonize new areas and quickly develop into thick masses of vegetation could significantly increase expenditures for maintenance removal of aquatics. In addition, floating mats could adversely affect the operation of control structures and could clog outlets, siphons, and weirs. Small irrigation intakes pumping from infested waters could become clogged with milfoil fragments.

f. Water Supply. Milfoil fragments can clog municipal or industrial water intakes, resulting in higher costs for cleaning and maintenance. The presence of heavy growths can result in the formation of undesirable tastes and odors in municipal water supplies and require additional treatment for removal. Milfoil can also clog small individual water intakes.

g. Esthetics. Milfoil, when it grows to the water surface, has a strong negative impact upon the esthetic aspects of lakes, streams, and other bodies of water. Floating trash and algae are trapped in the surface mats of milfoil, adding to the negative esthetic impact of the infestation. Decaying mats of milfoil could also cause unpleasant odors.

h. Public Health. Milfoil infestations could potentially impact public health because dense growth of milfoil at the water surface forms an ideal breeding area for mosquitoes. Of the diseases commonly transmitted by mosquitoes, encephalitis is the only one which could possibly be a problem in Washington.

i. Socioeconomic. The premium value of water view and shoreline properties is based on their water-oriented location. Waterfront land which has its water use restricted because of heavy milfoil growths could experience a decease in value. Firms dependent upon water-related recreation and tourism could lose business and reduce employment because of milfoil obstructions.

SECTION 3. FORMULATION AND EVALUATION OF ALTERNATIVES

3.01 Planning Objectives. Planning objectives of this study are:

- Prevent the spread of milfoil to navigable waters of the state, particularly the Columbia River.

- Control existing milfoil growth in the Lake Washington drainage basin.

- Preserve water quality consistent with accomplishments and standards of local and state governments.

3.02 Planning Constraints. Possible constraints, in addition to those imposed by Corps of Engineers regulations, include:

- The financial capabilities of state and local sponsors.

- The anadromous fishery resource of the Lake Washington and Okanogan drainage basins.

- The desires of the local people.

- Unsuccessful efforts to completely eradicate milfoil in other areas of the United States.

3.03 Selection Criteria. The following criteria were used in selecting areas for possible inclusion in an aquatic plant management program:

- The infestation is in a navigable water or in a nonnavigable water which directly threatens to cause the infestation of a navigable water.

- The infestation is of a degree which impairs navigation, recreation, flood control, hydropower, irrigated agriculture, or related purposes.

- The area is not located within an existing Federal project.

- Treatment of control or prevention area is economically justified.

- Treatment will not result in an unacceptable impact to the environment.

3.04 Evaluation of Alternative Treatment Methods. Evaluation involved determining the contributions of each alternative to the national planning objectives of national economic development and environmental quality of the Water Resources Council's principles and standards. Public input, vegetation surveys, aerial photographs, contacts with public recreation agencies, and the results of completed or ongoing Federal, state, or local studies were considered.

Alternative treatment methods were then evaluated with regard to economics, environmental concerns, effectiveness of control, and applicability to potential treatment areas.

Treatment methods eliminated in the initial screening are listed in table 3-1 with the reasons for their elimination. Treatment methods given extensive review for possible use in an aquatic plant management program are shown in table 3-2 and summarized below:

a. Mechanical Harvesting. Mechanical harvesting entails cutting aquatic vegetation 5 to 8 feet below the water surface and removing the cut vegetation from the water. The root systems are not affected, so the plants continue to grow. There are several different types of harvesters available, from large units which automatically pick up the cut plants to small cutter boats which require hand pickup. Because milfoil is spread by fragmentation, harvesting can speed its dispersal. Containment booms are often used around the treatment areas to minimize floating fragments, but they are not 100 percent effective. For these reasons, mechanical harvesting should be limited to areas which do not require complete control and do not directly threaten uninfested waters.

Another problem associated with harvesting milfoil is upland disposal. Transport and handling are expensive and attempts that have been made to find a use for the harvested milfoil, to partially defray the cost, have been unsuccessful. However, the cost of disposing of harvested milfoil may be minimized because preliminary tests indicate that milfoil can be composted for use as growth media in greenhouses.

b. Rotovating. Rotovating involves "tilling" the bottom sediment to a depth of 6 inches to dislodge plant roots. The plant parts float to the surface and are then removed. The treatment area is surrounded by containment booms to prevent the spread of fragments. This method is not 100 percent effective because all of the plants do not float, nor are they always completely removed.

Because of the environmental disruption caused by rotovating, it should be used only when complete removal of the plant is required, when the treatment area is too large for either hand pulling or a suction dredge, and when herbicide application is not possible.

c. Suction Dredge. The suction dredge involves the use of a small barge or boat equipped with compressors and suction hoses. The suction hoses are small and are controlled by divers, who use them to remove individual milfoil plants, roots, and all. The plant parts are carried through the hoses to a holding basket on the barge which separates the plants from the water and sediment. The water is discharged, along with the sediment, to the water body.

Because of the high cost and the limited amount of area which can be treated, the suction dredge is feasible only for small areas which require complete milfoil removal, are too large for hand removal, and cannot be treated with an herbicide.

TABLE 3-1

TREATMENT METHODS
ELIMINATED DURING PRELIMINARY REVIEW

METHOD	REASON FOR ELIMINATION
Chemical:	
simazine	Requires treatment of entire water body.
silvex	Banned by the Environmental Protection Agency.
fenac	Requires drawdown of water body for treatment.
endothall (dimethylamine (DMA))	Toxic to fish at concentration necessary to control milfoil.
Hydraulic Washing	Low efficiency/large environmental disruption (e.g., degradation of water quality and disruption of benthic organisms).
"Mud-Cat" Dredge	High cost/large environmental disruption (e.g., eliminates benthic organisms).
Bottom Barriers	High cost/problems with maintenance (e.g., subject to lifting by gas bubbles).
Sand and Gravel Blankets	High cost/large environmental disruption (e.g., elimination of benthic organisms)/permit requirements.

TABLE 3-2 ALTER

CONSIDERATIONS		CHEMICAL: 2, 4-D (DMA & BEE)	ENDOTHALL *	DIQUAT	DICHLOBENIL	HARVESTERS	
FRAGILE OR SENSITIVE ECOSYSTEMS	Advantages	Aquatic plant species diversity is not greatly reduced after treatment. No disruption of substrate. Selective for milfoil.	No disruption of substrate.	No disruption of substrate.	No disruption of substrate.	Area of treatment is controlled (no impact to nontarget area). No disruption of substrate.	Area troll targ rupt
	Disadvantages	Possible impacts with repeated use. Drift may affect nontarget areas.	It is a non-selective herbicide that will destroy many nontarget species and eliminate habitat and cover for a variety of aquatic organisms. Drift may affect nontarget areas.	It is a non-selective herbicide that will destroy many nontarget species and eliminate habitat and cover for a variety of aquatic organisms. Drift may affect nontarget areas.	It is a non-selective herbicide that will destroy many nontarget species and eliminate habitat and cover for a variety of aquatic organisms. Drift may affect nontarget areas.	Non-selective, eliminates habitat, food and cover for a variety of aquatic organisms.	Disk bent Non- vege
POTABLE WATER SUPPLY	Advantages	Rapid breakdown results in no long-term interruption of water use.	None.	None.	None.	Minimum disruption of water quality.	Short of wa
	Disadvantages	Before use laboratory analysis necessary to insure concentration is within allowable limits (0.1 ppm).	Cannot use treated water for 7 days after application.	Cannot use treated water for 14 days after application.	Cannot be used in potable water supplies.	None.	Temp foll May poll sedi
IRRIGATION WATER SUPPLY	Advantages	Will reduce clogging of intake structures.	Will reduce clogging of intake structures.	Will reduce clogging of intake structures.	Will reduce clogging of intake structures.	Does not disrupt use of irrigation water.	Short wate
	Disadvantages	Irrigation with treated water may result in damage to agricultural crops. Restrictions in use near intakes.	Cannot use treated water for 15 days after application.	Cannot use treated water for 10 days after application.	Cannot be used if water is used for food crops. Not recommended for other irrigated applications.	None.	Temp turbi ment poll sedi
FISHERIES	Advantages	Concentration level needed to control milfoil is below the toxicity of most fish species.	Concentration level needed to control milfoil is below the toxicity of most fish species.	Concentration level needed to control milfoil is below the toxicity of most fish species.	Concentration level needed to control milfoil is below the toxicity of most fish species.	No possible chronic impacts.	No po
	Disadvantages	Toxicity to some species is unknown. May have chronic effects with repeated use.	Toxicity to some species is unknown. May have chronic effects with repeated use.	Toxicity to some species is unknown. May have chronic effects with repeated use.	Toxicity to some species is unknown. May have chronic effects with repeated use.	May have some effect due to non-selective loss of aquatic vegetation. Some direct kill of small fish during harvesting.	Dest com adve aqua on t sele vege
WILDLIFE	Advantages	Acute mammalian and avian toxicity very low, non-bioaccumulative. Does not destroy most native vegetation.	Non-bioaccumulative. Concentration level needed to control milfoil is below the toxicity of most mammalian and avian species.	Non-bioaccumulative. Concentration level needed to control milfoil is below the toxicity of most mammalian and avian species.	Non-bioaccumulative. Concentration level needed to control milfoil is below the toxicity of most mammalian and avian species.	No possible chronic impacts.	No p impa
	Disadvantages	May have chronic toxic effects with repeated usage.	May have chronic toxic effects with repeated usage.	May have chronic toxic effects with repeated usage.	May have chronic toxic effects with repeated usage.	May have minor effects on wildlife due to non-selective loss of vegetation.	May wild sele vege
PERFORMANCE (EFFECTIVENESS)	Advantages	Quickly kills roots as well as stems at concentrations that are not harmful to most other desirable species.	Very effective in controlling milfoil.	Very effective in controlling milfoil.	Very effective in controlling milfoil. Systemic - will cause some root kill.	Very effective in removing weed stems to depth of 8 feet. Immediate relief- few changes to water column or bottom.	66% dom of r and 2 depe anti dist
	Disadvantages	Area can be reinfested by fragments from outside the treatment area due to short persistence in water column. Application rate important (too little stimulates growth) (too much kills only stems and leaves).	Contact herbicide, kills stems only. Plants will grow back in 6 months to 1 year.	Contact herbicide, kills stems only. Plants will grow back in 6 months to 1 year.	Most plants will grow back in 6 months to 1 year.	Regrowth to surface possible within 1 month. Causes spread of fragments. Stimulates regrowth of plant. Shore disposal of wet weeds.	Short turb in r disp
ECONOMIC (COST)		2,4-D (DMA) $770/acre 2,4-D (BEE) $760/acre	liquid $960/acre. granular $1,470/acre	$790/acre.	$1,265/acre.	$920/acre includes two cuttings/year.	$600 ($50

*DIPOTASSIUM SALT

LE 3-2 ALTERNATIVE TREATMENT METHODS

	MECHANICAL			ENVIRONMENTAL MANIPULATION		BIOLOGI
WESTERS	**ROTOVATORS**	**SUCTION DREDGE**	**HAND REMOVAL**	**BOTTOM SHADING**	**WATER LEVEL FLUCTUATIONS**	**HERBIVOROUS FISH**
atment is con- impact to non- a). No dis- substrate.	Area of treatment is con-trolled (no impact to non-target area). No dis-ruption of substrate.	Very selective in treatment *area and somewhat* selective in plant removal.	Very selective for treatment area.	Very selective for treat-ment area.	None.	None.
ive, eliminates od and cover for of aquatic	Dislodges and exposes benthic organisms. Non-selective removal of vegetation.	Non-selective loss of vegetation in turbid waters.	None.	Disruption of benthic communities.	Dewatering of the shore zone *would kill aquatic plants*, benthic organisms, severe disruption to the littoral habitat.	Possible unforeseen *adverse interactions* with native species.
ruption of ty.	Short term disruption of water quality.	No disruption of water quality or long term effects.	No long term disruption of water quality.	No disruption of water quality.	No disruption of water quality.	None
	Temporary localized turbidity following treatment. May release bound pollutants from the sediments.	Some temporary localized turbidity to small areas during treatment.	Temporary localized turbidity to small areas during treatment.	None.	Could result in water levels that are below water intakes. Shore erosion resulting from dewatering could cause water quality problems.	May decrease water quality by increasing algae during certain periods.
disrupt use of water.	Short term disruption of water quality.	*Does not disrupt use of* irrigation water.	Does not disrupt use of irrigation water.	Does not disrupt use of irrigation water.	None.	Does not disrupt use of irrigation water.
	Temporary localized turbidity following treat-ment. May release bound *pollutants from the* sediments.	None.	None.	None.	May result in water levels that are below water in-takes and less irrigation water supply.	None.
le chronic impacts.	No possible chronic impacts.	No possible *chronic* impacts.	No chronic impacts, small area *affected.*	No chronic impacts, small area affected,	No possible chronic impacts.	No possible chronic impacts.
some *effect* due to tive loss of egetation. Some ill of small fish rvesting.	Destruction of benthic communities may have adverse effects on other aquatic organisms that feed on the benthos. Non-selective loss of aquatic vegetation.	Very slight impact due to increased turbidity.	Slight impact due to increased turbidity.	Very slight impact due to non-selective loss of vegetation,	Non-selective loss of aquatic vegetation. Dewater-ing of the shore zone can *kill benthic organisms, fish*, and fish eggs.	Imported species may adversely affect existing fish populations.
le chronic	No possible *chronic* impacts.	No possible chronic impacts, small area affected.	No possible chronic impacts, small area affected.	No possible chronic impacts small area affected.	No possible chronic impacts.	No possible chronic im-pacts.
minor effects on due to non- loss of m.	May have minor effects on wildlife due to non-selective loss of vegetation.	May have minor effects due to non-*selective* loss of vegetation.	None.	May have minor effects due to non-selective loss *of vegetation.*	Dewatering on the littoral zone could have adverse impacts on resident and migratory waterfowl and shore birds that feed and nest in shore zones.	None.
ctive in removing to depth of 8 mediate relief- es to water bottom.	66% removal of roots in "ran-dom"-traverses. 95% removal of roots in circular patterns and 2 passes. Operates in deeper water than other mech-anical methods. Local disturbance only.	90% *effective in removing* plants to any depth. Use-ful for small areas. Successful use in rocky areas and near obstacles.	*Useful for confined areas*, rocky areas and near *obstacles.*	Material is reusable, use-ful for small confined areas, rocky areas, and near obstacles. Impact localized to the area treated. 95% *effective after 14 days of* coverage.	100% effective on well drained slopes in the dewatered zone.	This method has not been sufficiently developed for practical application.
to surface poss-hin 1 month. Causes fragments. Stim-egrowth of plant. sposal of wet	Short term increases in turbidity. Cannot operate in rough weather. Shore disposal of wet weeds.	Regrowth possible in 1-2 years. Suitable for treat-ment of small areas only. Susceptible to storms and public interference. Slow and labor intensive.	Very limited in possible scope, labor intensive, very costly.	Subject to lifting by gas bubbles. Anchoring may be difficult.	Can only be used in water bodies where the level can be controlled.	
two cuttings/year.	$600 to $700/acre ($50,000 capital cost)	$800 to $900/acre ($12,000 capital cost).	Is labor intensive and expensive. Actual costs dependent upon situation.	$10,870/acre installed.	Cost estimates have not been developed.	This method is still being researched. No cost estimates are available.

ULATION	BIOLOGICAL	
R LEVEL FLUCTUATIONS	HERBIVOROUS FISH	INSECTS, PATHOGENS, ETC.
ne.	None.	None.
atering of the shore zone uld kill aquatic plants, nthic organisms, severe ruption to the littoral bitat.	Possible unforeseen adverse interactions with native species.	Possible unforeseen adverse interactions with native species.
disruption of water ality.	None.	No disruption of substrate or introduction of chemicals to the water.
uld result in water levels t are below water intakes. re erosion resulting from atering could cause water ality problems.	May decrease water quality by increasing algae during certain periods.	None.
e.	Does not disrupt use of irrigation water.	Does not disrupt use of irrigation water.
y result in water levels t are below water in- kes and less irrigation ter supply.	None.	None.
o possible chronic impacts.	No possible chronic impacts.	Potential food source for other aquatic organisms.
on-selective loss of quatic vegetation. Dewater- ng of the shore zone can ill benthic organisms, fish, nd fish eggs.	Imported species may adversely affect existing fish populations.	May adversely affect existing fish food sources.
o possible chronic impacts.	No possible chronic impacts.	
Dewatering on the littoral zone could have adverse impacts on resident and migratory waterfowl and shore birds that feed and nest in shore zones.	None.	This method is still being studied. Potential impacts are being investigated.
100% effective on well drained slopes in the dewatered zone.	This method has not been sufficiently developed for practical application.	This method has not been sufficiently developed for practical application.
Can only be used in water bodies where the level can be controlled.		
Cost estimates have not been developed.	This method is still being researched. No cost estimates are available.	This method is still being researched. No cost estimates have been developed.

TABLE 3-2 A

CONSIDERATIONS		CHEMICAL: 2, 4-D (DMA & BEE)	ENDOTHALL *	DIQUAT	DICHLOBENIL	HARVESTERS
PHYSICAL (BOTTOM COMPOSITION AND CONFIGURATION, OBSTACLES, DEPTH, WATER CURRENTS, ETC.)	Advantages	Can be used in localized areas. Not hindered by bottom type or underwater obstacles. No alteration of the bottom.	Can be used in localized areas. Not hindered by bottom type or underwater obstacles. No alteration of the bottom.	Can be used in localized areas. Not hindered by bottom type or underwater obstacles. No alteration of the bottom.	Can be used in localized areas. Not hindered by bottom type or underwater obstacles. No alteration of the bottom.	No alteration of the bottom.
	Disadvantages	Cannot be used in rapidly moving water.	Cannot be applied in rapidly moving water.	Cannot be applied in rapidly moving water.	Cannot be applied in rapidly moving water.	Cannot be used in confin areas or near obstacles. Rough water conditions must be avoided.
RECREATION (WATER CONTACT AND NONWATER CONTACT)	Advantages	There are no swimming, water skiing or fishing restrictions following treatment with 2,4-D.	None.	There are no restrictions on fishing after treatment.	There are no restrictions on swimming after treatment.	There are no restriction on recreational use afte physical removal of harvester.
	Disadvantages	None.	Fish from treated water cannot be used for food or feed for 3 days after application. Swimming should be restricted for 24 hours after treatment.	Swimming should be restricted for 10 days following application.	Fish from treated water can not be used for food or feed for 90 days following application.	Swimmers, boaters and wa skiers would have to avo harvesting equipment during harvesting operations.
NAVIGATION (COMMERCIAL)	Advantages	None.	None.	None.	None.	None.
	Disadvantages	None.	None.	None.	None.	Could interrupt or comp navigation routes durin treatment operations.
HYDROPOWER	Advantages	None.	None.	None.	None.	Would remove aquatic vegetation from the wate decreasing floating mate which could clog water intakes.
	Disadvantages	None.	None.	None.	None.	None.
HUMAN TOXICITY		Fairly low toxicity. May have chronic effects with repeated exposure.	Acute and chronic toxicities unknown.	Acute and chronic toxicities unknown.	Acute and chronic toxicities unknown.	None.
REGULATORY REQUIREMENTS (PERMITS, VARIANCES, REGISTRATION, LICENCES, ETC.)		Commercial preparations must have an EPA approved label and a registration number. The applicator must be licensed and label restrictions must be followed. A water quality variance from the Department of Ecology is required.	Commercial preparations must have an EPA approved label and a registration number. The applicator must be licensed and label restrictions must be followed. A water quality variance from the Department of Ecology is required.	Commercial preparations must have an EPA approved label and a registration number. The applicator must be licensed and label restrictions must be followed. A water quality variance from the Department of Ecology is required.	Commercial preparations must have an EPA approved label and a registration number. The applicator must be licensed and label restrictions must be followed. A water quality variance from the Department of Ecology is required.	None.
AVERAGE RATE		2,4-D (DMA) 100 acres/day 2,4-D (BEE) 80 acres/day	endothall liquid 100 acres/day endothall granular 16 acres/day	100 acres/day.	50 acres/day	Up to 10 acres per da Average about 6 acres per day. (Aqua-Trio Unit) Less for smaller units

* DIPOTASSIUM SALT

TABLE 3-2 ALTERNATIVE TREATMENT METHODS

MECHANICAL				ENVIRONMENTAL MANIPULATION		
HARVESTERS	ROTOVATORS	SUCTION DREDGE	HAND REMOVAL	BOTTOM SHADING	WATER LEVEL FLUCTUATION	HERBIVOR
No alteration of the bottom.	None.	Can be used on a rocky substrate and near obstacles.	Diver can go anywhere to remove small patches.	No permanent alterations of bottom. Can be used near obstacles and in any depth water. No disturbance to water column. Sediments are not disturbed.	Not affected by obstruction.	Not affected by
Cannot be used in confined areas or near obstacles. Rough water conditions must be avoided.	Cannot operate in confined areas or near obstacles. Rough water conditions must be avoided.	None.	Raking or hand pulling can be used only in shallow shore zones.	Subject to storm and wave damage.	Drawdown can cause shore erosion.	None.
There are no restrictions on recreational use after physical removal of harvester.	No long-term recreational restrictions.	No restriction to recreational use.	No restriction to recreational use.	No restriction to recreational use.	None.	No restriction recreational us
Swimmers, boaters and water skiers would have to avoid harvesting equipment during harvesting operations.	Swimmers, boaters, and water skiers would have to avoid rotovating equipment during treatment and operations. Water turbidity would discourage recreational use.	Swimmers, boaters, and water skiers would have to avoid dredging equipment during treatment operations.	Swimmers, boaters and water skiers would have to avoid areas during operation.	Could limit swimming and boating activities during the treatment period.	Drawdown operations during spring and summer could restrict use of recreational facilities.	None.
None.	None.	None.	None.	None.	None.	None.
Could interrupt or congest navigation routes during treatment operations.	Could interrupt or congest navigation routes during treatment operations.	Could interrupt or congest navigation routes during treatment operations.	None.	None.	Drawdown operations could adversely affect the depth of navigation channels.	None.
Would remove aquatic vegetation from the water, decreasing floating mats which could clog water intakes.	Would remove aquatic vegetation from the water, decreasing floating mats which could clog water intakes.	None.	None	None.	None.	None.
None.	None.	None.	None.	None.	Drawdown operations could be limited by the location of multi-level intakes. Could affect hydropower capacity.	None.
None.	None.	None.	None.	None.	None.	None.
None.	May require Department of the Army and State of Washington shoreline permits due to the alteration of the bottom.	None.	None.	Would require Department of the Army and State shoreline permits for installation in navigable waters.	Permits could be required for drawdown operations.	Washington Stat hibits the impo exotic species. law requires U. of Agriculture testing of exot
Up to 10 acres per day. Average about 6 acres per day. (Aqua-Trio Unit) Less for smaller units.	0.5 acre/day average depending on number of passes.	0.9 acre/day (average) depends on weed density.	Minimal.	1 acre/day.	Variable.	Unknown.

...MENTAL MANIPULATION	BIOLOGICAL	
...ING WATER LEVEL FLUCTUATION	HERBIVOROUS FISH	INSECTS, PATHOGENS, ETC.
...ions need ...n any ...ctur- ...e. ...isturbed.	Not affected by obstruction.	Not affected by obstruction.	Not affected by obstruction.
...wave	Drawdown can cause shore erosion.	None.	None.
	None.	No restriction to recreational use.	This method is still being studied. Potential impacts are being investigated.
...and ...ring ...e	Drawdown operations during spring and summer could restrict use of recreational facilities.	None.	
	None.	None.	None.
	Drawdown operations could adversely affect the depth of navigation channels.	None.	None.
	None.	*None.*	*None.*
	Drawdown operations could be limited by the location of multi-level intakes. Could affect hydropower capacity.	None.	None.
	None.	None.	None.
...ment ...e ...gable	Permits could be required for drawdown operations.	Washington State law prohibits the importation of exotic species. Federal law requires U.S. Department of Agriculture review and testing of exotic species.	Washington State law prohibits the importation of exotic species. Federal law requires U.S. Department of Agriculture review and testing of exotic species.
	Variable.	Unknown.	Unknown.

d. Hand Removal. Hand removal can consist of either pulling individual plants by hand, which removes the roots, or by using a rake or other tool, which would remove only the foliage. This method is obviously limited, but can be used to clear around private piers or to remove small patches to prevent spread. In deeper water, divers and special equipment would be required.

e. 2,4-D. The chemical 2,4-dichlorophenoxyacetic acid (2,4-D) is a systemic herbicide which kills the milfoil roots as well as the upper plant portion. One treatment per year generally provides adequate control. 2,4-D has a high degree of selectivity for milfoil and does not affect most native species at recommended treatment concentrations. It is suitable for use in most Washington State waters currently infested with milfoil. It would be especially useful in areas that are too large for hand removal or suction dredging and where complete control is required. 2,4-D would have use restrictions (generally less than 2 weeks) in the vicinity of domestic or irrigation water intakes and salmon spawning and rearing areas although there are no label restrictions on swimming, water-skiing, or fishing. Two different formulations of 2,4-D could be used for milfoil control: a liquid, dimethylamine salt (DMA); and a granular form, butoxyethanol ester (BEE). 2,4-D is not toxic to humans at concentrations necessary to control milfoil. The scientific literature concerning the carcinogenicity (cancer producing), teratogenicity (birth defects), and fetotoxicity (fetal health and development) are not considered conclusive because:

- there are conflicting scientific interpretations of the same data, particularly concerning carcinogenicity,

- most laboratory tests have been designed and conducted to investigate ingestion and do not represent conditions which will occur in an aquatic plant environment.

f. Endothall (Dipotassium Salt), Dichlobenil, and Diquat. Diquat and the dipotassium salt formulation of endothall, hereafter referred to as endothall, are contact herbicides; they kill the leaves and stems but do not affect aquatic plant roots. Dichlobenil is systemic and thus would cause some root kill. These chemicals are not selective to milfoil; they would also kill many native species of aquatic plants. For this reason, their use is intended primarily for areas in which the exclusion of all aquatic growth is acceptable (e.g., swimming beaches).

These chemicals could kill many terrestrial plant species, so care must be taken to insure that irrigation water is not treated. There are also some restrictions on swimming, fishing, and drinking the treated water for a period of time after the treatment. One treatment per year should give adequate control.

Herbicide concentrations in the water column would vary depending on the depth of water at the application site. Table 3-3 presents maximum theoretical concentrations at varying depths resulting from application rates in accordance with label instructions. These data have been developed in order to convert application rates to comparable units that are found in scientific data. These data are considered to be maximum theoretical concentrations based upon the following assumptions:

- There will be immediate release (in the case of granular formulations) of the herbicides and a homogeneous mixture will be attained throughout the volume of water.

- There is no dilution, no drift outside the treatment area, no photodecomposition, and no hydrolysis of BEE.

- There will be no absorption or adsorption of the herbicide by aquatic macrophytes, organic material, or sediments in the treatment area.

Based on these assumptions, actual concentrations in the field would be lower than the calculated data shown on table 3-3.

g. Fiberglass Bottom Screens. Bottom screens involve the installation and anchoring of a polyvinyl chloride-coated fiberglass screen. The screen limits sunlight penetration and effectively eliminates all aquatic growth in the affected area.

Because of the cost of the screen and the fact that it eliminates all growth, it is used generally for high-use areas where the exclusion of all aquatic growth is acceptable (e.g., swimming beaches).

h. Integrated Control. Integrated control, the use of two or more control techniques in conjunction, has been shown to be effective in some situations. For instance, 2,4-D is most effective when applied to milfoil which is rapidly growing. Mechanical harvesting causes a spurt of growth, so chemical treatment immediately following harvest would be very effective. Because integrated control is expensive, it would only be practical if it could reduce the number of treatments necessary per year.

i. Aerial Surveillance. Aerial surveillance is used to monitor the spread of milfoil. Aerial photographs using special film would be taken of areas having a high possibility of becoming infested or having a large potentially adverse impact from milfoil infestation. New infestations identified by photographic interpretation would be treated before they could become major problems.

TABLE 3-3

MAXIMUM THEORETICAL CONCENTRATIONS
OF ALTERNATIVE CHEMICAL CONTROL METHODS

Water Depth	Cubic feet/ acre	Liter/acre	2,4-D BEE granular BEE (29%) 29 lb/acre mg/l	2,4-D BEE granular 2,4-D (20%) 20 lb/acre mg/l	2,4-D DMA Liquid 40 lb/acre 1/ mg/l	Endothall Liquid 30 lb/acre mg/l	Endothall Granular 50 lb/acre mg/l	Dichlobenil Granular 150 lb/acre mg/l	Diquat Liquid 4 lb/acre mg/l
2	87,120	2,466,890	5.33	3.68	3.68	5.52	9.19	2.76	0.74
4	174,240	4,933,780	2.67	1.84	1.84	2.76	4.60	1.38	0.37
6	261,360	7,400,670	1.78	1.23	2.45	1.84	3.06	0.92	0.25
8	348,480	9,867,560	1.33	0.92	1.84	1.38	2.30	0.69	0.18
10	435,600	12,334,450	1.07	0.74	1.47	1.10	1.84	0.55	0.15
12	522,720	14,801,340	0.89	0.61	1.23	0.92	1.53	0.46	0.12
14	609,840	17,268,229	0.76	0.53	1.05	0.79	1.31	0.39	0.10
16	696,960	19,735,119	0.67	0.46	0.92	0.69	1.15	0.34	0.09
18	784,080	22,202,009	0.59	0.41	0.82	0.61	1.02	0.31	0.08
20	871,200	24,668,899	0.53	0.37	0.74	0.55	0.92	0.27	0.07

1/The application rate for liquid 2,4-D DMA is 5 gallons/acre (20 lb/acre) in water 4 feet deep or less and 10 gallons/acre (40 lb/acre) in water greater than 4 feet deep.

Herbicide concentrations in the water column would vary depending on the depth of water at the application site. Table 3-3 presents maximum theoretical concentrations at varying depths resulting from application rates in accordance with label instructions. These data have been developed in order to convert application rates to comparable units that are found in scientific data. These data are considered to be maximum theoretical concentrations based upon the following assumptions:

- There will be immediate release (in the case of granular formulations) at the herbicides and a homogeneous mixture will be attained throughout the volume of water.

- There is no dilution, no drift outside the treatment area, no photodecomposition, and no hydrolysis of BEE.

- There will be no absorption or adsorption of the herbicide by aquatic macrophytes, organic material, or sediments in the treatment area.

Based on these assumptions, actual concentrations in the field would be lower than the calculated data shown on table 3-3.

g. Fiberglass Bottom Screens. Bottom screens involve the installation and anchoring of a polyvinyl chloride-coated fiberglass screen. The screen limits sunlight penetration and effec- tively eliminates all aquatic growth in the affected area.

Because of the cost of the screen and the fact that it eliminates all growth, it is used generally for high-use areas where the exclusion of all aquatic growth is acceptable (e.g., swimming beaches).

h. Integrated Control. Integrated control, the use of two or more control techniques in conjunction, has been shown to be effective in some situations. For instance, 2,4-D is most effective when applied to milfoil which is rapidly growing. Mechanical harvesting causes a spurt of growth, so chemical treatment immediately following harvest would be very effective. Because integrated control is expensive, it would only be practical if it could reduce the number of treatments necessary per year.

i. Aerial Surveillance. Aerial surveillance is used to monitor the spread of milfoil. Aerial photographs using special film would be taken of areas having a high possibility of becoming infested or having a large potentially adverse impact from milfoil infestation. New infestations identified by photographic interpretation would be treated before they could become major problems.

TABLE 3-3

MAXIMUM THEORETICAL CONCENTRATIONS
OF ALTERNATIVE CHEMICAL CONTROL METHODS

Water Depth	Cubic feet/ acre	Liter/acre	2,4-D BEE granular BEE (29%) 29 lb/acre mg/l	granular 2,4-D (20%) 20 lb/acre mg/l	2,4-D DMA Liquid 40 lb/acre 1/ mg/l	Endothall Liquid 30 lb/acre mg/l	Endothall Granular 50 lb/acre mg/l	Dichlobenil Granular 150 lb/acre mg/l	Diquat Liquid 4 lb/acre mg/l
2	87,120	2,466,890	5.33	3.68	3.68	5.52	9.19	2.76	0.74
4	174,240	4,933,780	2.67	1.84	1.84	2.76	4.60	1.38	0.37
6	261,360	7,400,670	1.78	1.23	2.45	1.84	3.06	0.92	0.25
8	348,480	9,867,560	1.33	0.92	1.84	1.38	2.30	0.69	0.18
10	435,600	12,334,450	1.07	0.74	1.47	1.10	1.84	0.55	0.15
12	522,720	14,801,340	0.89	0.61	1.23	0.92	1.53	0.46	0.12
14	609,840	17,268,229	0.76	0.53	1.05	0.79	1.31	0.39	0.10
16	696,960	19,735,119	0.67	0.46	0.92	0.69	1.15	0.34	0.09
18	784,080	22,202,009	0.59	0.41	0.82	0.61	1.02	0.31	0.08
20	871,200	24,668,899	0.53	0.37	0.74	0.55	0.92	0.27	0.07

1/The application rate for liquid 2,4-D DMA is 5 gallons/acre (20 lb/acre) in water 4 feet deep or less and 10 gallons/acre (40 lb/acre) in water greater than 4 feet deep.

j. Ground Surveillance. Ground surveillance would be provided by Federal, state, or local resource management personnel normally in the field. They would be trained in milfoil identification and would notify the state coordinator or the Corps of Engineers of any milfoil growth they discover during the course of their normal work.

Special teams would be sent out to survey areas identified by the aerial surveillance. The object of ground surveillance would be the same as the aerial surveillance: to locate and eliminate new colonies of milfoil before they become a major problem. The ground surveillance program would have an advantage over the aerial surveillance program in that it would be able to identify smaller milfoil colonies. The aerial surveillance program, however, would be able to cover a larger area.

k. Fragment Barriers. Barriers would be used to stop the downstream spread of floating milfoil fragments in flowing water systems which feed directly into uninfested waters. Barriers consist of a floating log boom with fine mesh net extending 3 to 4 feet below the water surface. Each barrier is 80 to 90 percent effective in stopping milfoil fragments; therefore, the surveillance programs would have to be used to monitor new colonies downstream of the barriers.

l. Public Information. A public information program would help stop the spread of milfoil caused by human activity and also obtain information on new colonies.

Milfoil can be spread from lake to lake by recreational boating activity. The public information program would alert the boating public to this problem and encourage them to remove all aquatic plant fragments from their boats and trailers before leaving boat ramps. Boat ramps would be posted with signs requesting boaters to assure that they are not transporting milfoil fragments.

The public would also be made aware that many problem aquatic species are spread through the aquarium industry. Local aquarium shops could be monitored for nuisance species and the public could be asked to dispose of aquarium plants in such a way that they would not enter state waters.

The public information program would also provide tips for identifying milfoil and encourage private citizens to report any suspected colonies to their local government, the state coordinator, or the Corps of Engineers.

m. Biological Control. Biological control entails introducing predator species, parasites, or pathogens into milfoil infested waters. Research is being done on several possible biological control agents for milfoil, but none are available at this time.

n. Water Level Fluctuation. Water level fluctuation involves artificially raising and lowering a water body to put stress on the milfoil populations. It has been shown effective on well drained soil, when used in a daily cycle, and in longer term drawdowns.

Water level fluctuation is not feasible at this time because of the lack of drawdown capabilities in the affected waters. However, this control method should be considered for use if treatment becomes necessary in reservoirs or other waters which can be regulated.

3.05 Alternative Scopes of a Prevention Program.

a. No Action. The no action alternative would result in the continued spread of milfoil throughout the state. In time, most of the reservoirs on the Columbia River would have heavy infestations which would greatly interfere with their use. Irrigated areas of the state, notably the Yakima Valley and the Columbia Basin, could be heavily impacted by the interference to waterflow from the presence of milfoil in irrigation systems.

b. Surveillance and Treatment of All Waters in the State. This would be an effort to discover and eradicate new milfoil colonies wherever they occurred in the state, regardless of their possible threat to navigable waters. Such an effort would require extensive control and eradication efforts upon all existing milfoil infestations, since milfoil is spread by the carrying of fragments from one area to another. This is not a cost-effective approach, nor would it be environmentally acceptable.

c. Surveillance and Treatment of High Risk Areas. This alternative would concentrate efforts upon those navigable waters having the highest probability of becoming infested because of proximity to existing infestation and upon nonnavigable waters where small existing infestations may spread to navigable waters.

3.06 Alternative Scopes of a Control Program.

a. No Action. Without a comprehensive Federal control program, milfoil treatment in Lakes Washington, Union, and Sammamish would fall to local governments, park departments, property owners, and other interests. Public recreation areas could be treated under normal operation and maintenance funding if available. Treatment costs could, however, result in cutbacks to other types of maintenance or a reduction in recreation services.

b. Treatment of All Known Milfoil Colonies (Eradication). An eradication program would involve treatment of the shallow water areas of Lake Washington, Lake Union, Lake Sammamish, and the Sammamish

River (see figures 3-1 and 3-2), plus all nonnavigable waters which have milfoil colonies.

Because of the necessity to eliminate the milfoil root structure, an eradication program would have to utilize large amounts of the herbicide 2,4-D or dichlobenil. Limited use could be made of diver-operated suction dredges, hand pulling, and rotovators.

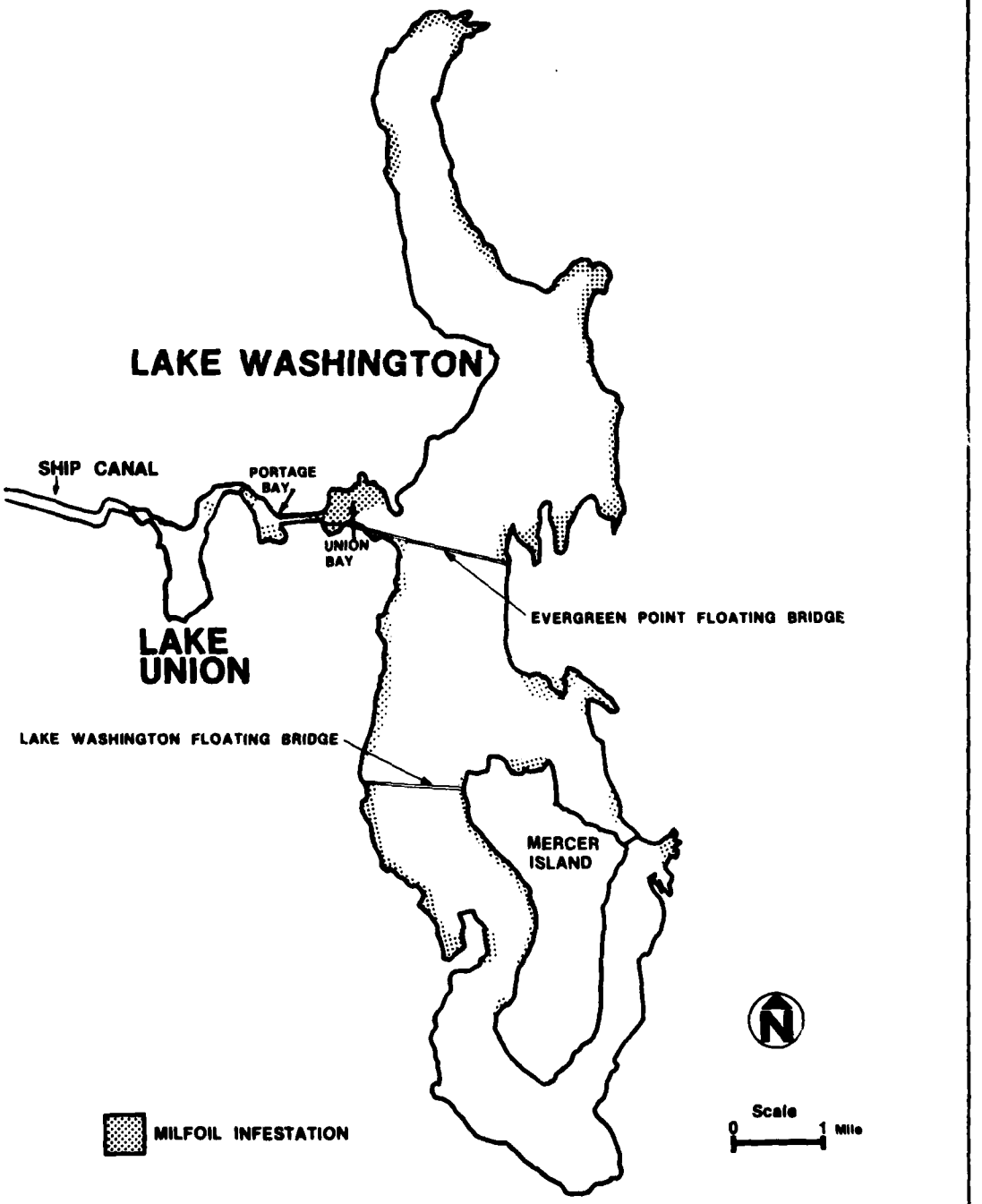
Problems which would be associated with a milfoil eradication effort are: (1) public opposition to the extensive use of chemicals in public waters; (2) because of the wide distribution of milfoil, an eradication effort would be very costly and, based on previous national experience, could be impossible to achieve; (3) milfoil colonies in Canada would still provide a continuous source of fragments to Washington waters; and, (4) major milfoil infestations which now cover large areas of the Bureau of Reclamation's Columbia Basin Irrigation Project reservoirs in eastern Washington would have to be treated concurrently but independently of a Corps-State Aquatic Plant Management Program.

c. Treatment of Selected Areas. Treatment of selected public use areas would involve waterfront parks, swimming beaches, boat launch ramps, and general boating areas. This alternative eliminates obstructions to the most severly impacted areas and does not cause excessive environmental disruption.

3.07 Plan Selection. Public input, vegetation surveys, aerial photographs, contacts with public recreation agencies, and the results of completed or ongoing Federal, state, or local studies, have been considered. The selected plan consists of prevention and control measures. This is the national economic development plan since it has the highest net economic benefits. The selected aquatic plant management plan is:

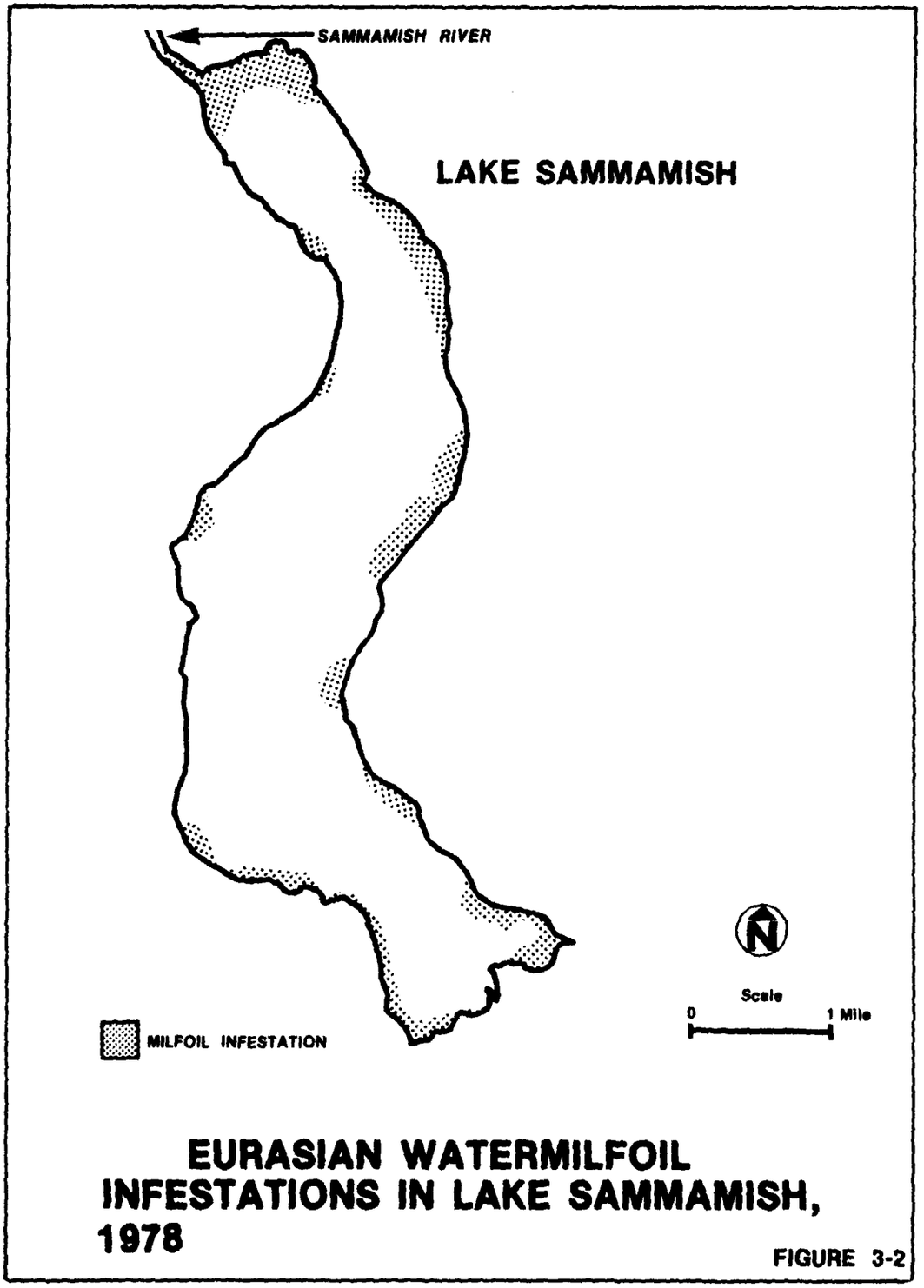
- Prevention Program. Since a major means of spreading milfoil is through direct flow from an infested water body to an uninfested water body, surveillance and spot treatment of these areas were assigned the highest priority. Water bodies selected for inclusion are Osoyoos Lake, Okanogan River, and four Columbia River reservoirs. Prevention also includes public awareness, training, and reporting.

- Control Program. In navigable waters presently infested with milfoil, treatment measures would be beneficial and would restore areas to usage levels desired by the public. The Lake Washington drainage basin is the single area selected for control measures in 1980. Because the major concerns expressed with milfoil growth are recreation related, only public areas currently being used for recreation are included in a control program. Water bodies selected within the drainage basin are Lake Washington, Lake Union, and Lake Sammamish.



EURASIAN WATERMILFOIL INFESTATIONS IN THE LAKE WASHINGTON/LAKE UNION SYSTEM, 1978

FIGURE 3-1



EURASIAN WATERMILFOIL INFESTATIONS IN LAKE SAMMAMISH, 1978

FIGURE 3-2

SECTION 4. THE PROPOSED PLAN

4.01 General. The proposed plan is designed to prevent the spread of milfoil to uninfested navigable waters and control existing milfoil growth at high-use public areas in navigable waters. Monitoring and evaluation will be necessary because of public concern over the use of chemicals which may be used in prevention or control operations and to determine the overall effectiveness of the aquatic plant management program. Treatment methods which may be used in prevention and control operations are:

- Prevention - Rotovating, hand removal, suction dredging, fragment barriers, or the herbicide 2,4-D.

- Control - Mechanical harvesting, fiberglass bottom screens, 2,4-D, endothall, diquat, or dichlobenil.

The methods or combination of methods that may be utilized are specific to each site proposed for treatment.

If performance of the aquatic plant management program is limited by funding, time, or manpower, the work proposed under the prevention program will be given higher priority for accomplishment than work proposed under the control program.

4.02 Description of Plan.

a. Prevention Program. The objective of the prevention program is to halt the spread of milfoil from infested water bodies to uninfested navigable waters. Eradication of new pioneer colonies will be accomplished before they become firmly established. This will involve spot treatment of small areas with a minimum of fragments. Hand removal of scattered plants or small colonies will be utilized where appropriate. Suction dredging (small suction hoses operated by scuba divers) is being successfully used in Canada and would be utilized where appropriate. Rotovating the bottom sediment to dislodge roots will also be appropriate on a limited basis. Use of 2,4-D is an acceptable treatment method because it is selective for milfoil and has a low cost.

In addition, the prevention program will employ aerial and ground surveillance to identify new colonies, a public information program to reduce man-caused spread by boats, and fragment barriers to stop the flow of milfoil fragments downstream. The Department of Ecology will be responsible for establishing a public information program in cooperation with Corps of Engineers and local governments. The following areas are included in the 1980 prevention program:

(1) Osoyoos Lake. Osoyoos Lake lies north of Oroville in Okanogan County and extends into Canada. It is 10 miles long with a total surface area of 5,729 acres, of which 3,693 acres lie in

British Columbia and 2,036 acres in the United States. It is drained by the Okanogan River, which flows southward to its confluence with the Columbia River near Brewster (see figure 1-3). The northern half of Osoyoos Lake lies in Canada and has significant colonies of milfoil, which are a constant source of fragments for the southern (United States) half. The southern half of Osoyoos Lake has a few small "pioneer" colonies and scattered milfoil plants and is a source of fragments for the Okanogan River. The proposal for Osoyoos Lake is to immediately treat all patches of milfoil identified by aerial and ground surveillance, and to eliminate fragments floating down the Okanogan River.

(2) Okanogan River. The Okanogan River drains Osoyoos Lake and is therefore subject to fragmented milfoil floating downstream (see figure 1-3). Small colonies of milfoil have been reported in the upper Okanogan River channel below Osoyoos Lake. The proposal for the Okanogan River is to conduct aerial and ground surveillance to pinpoint existing colonies, to operate and maintain the established barrier structure downstream of known milfoil colonies to slow the spread of fragments, and to treat colonies in the river channel to eliminate fragment sources.

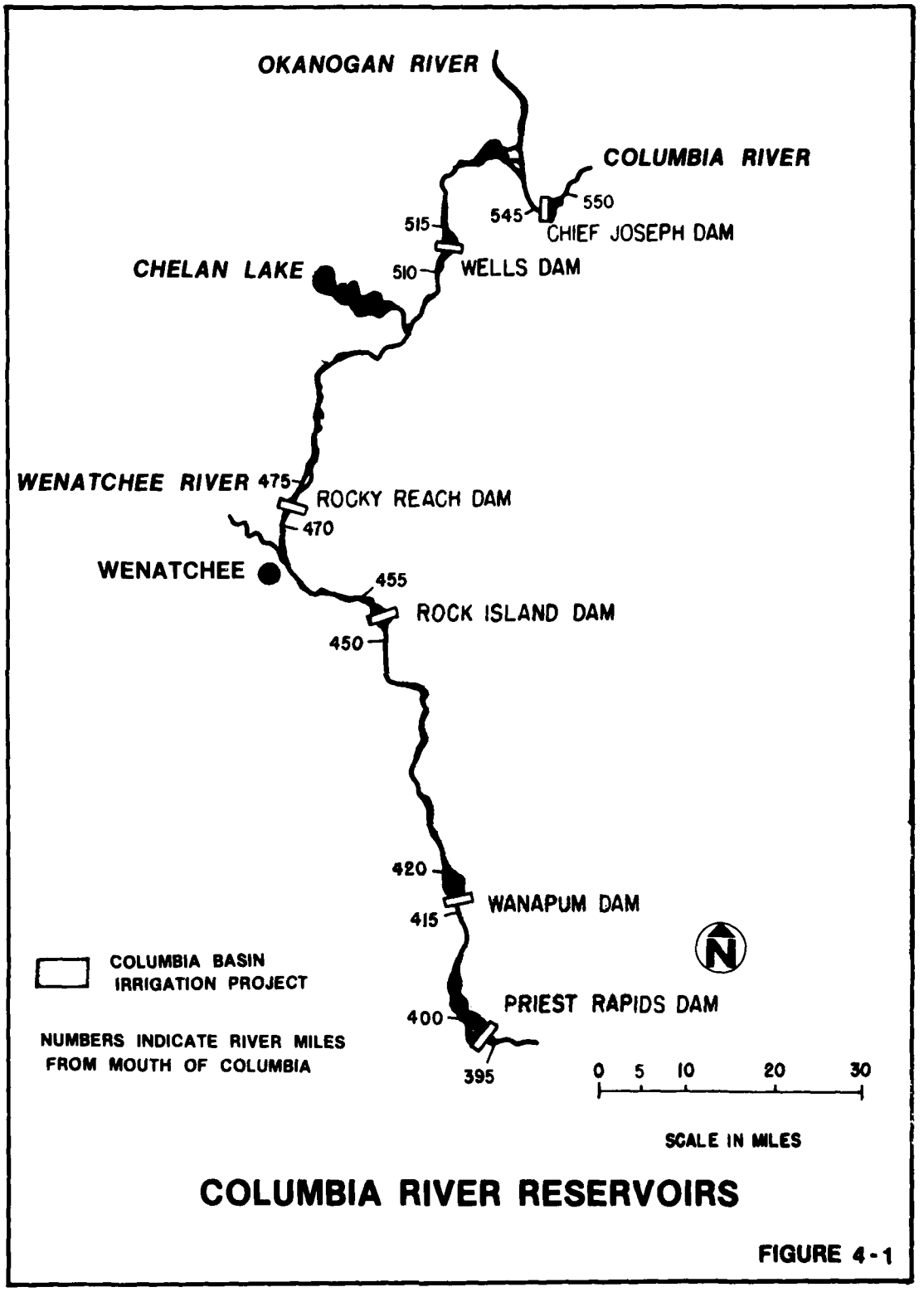
(3) Columbia River. The five Columbia River reservoirs which lie downstream from the mouth of the Okanogan River are also adjacent to the Columbia Basin Irrigation Project which has several existing sources of milfoil fragments (see figure 4-1). These reservoirs are Wells, Entiat Lake, Rock Island, Wanapum, and Priest Rapids. All except Rock Island Reservoir are included in the first year surveillance and treatment program. Rock Island was not included because there has been no potentially infestable area identified in this reservoir.

(a) Wells Reservoir. Wells Reservoir, created by Wells Dam at river mile (R.M.) 515.8 on the Columbia River at Azwell, is 29.5 miles long and extends upstream to Chief Joseph Dam. The principal tributaries to the Columbia in this stretch include the Okanogan River and the Methow River. Total surface area of Wells Reservoir is 9,700 acres, with a maximum depth of 109 feet.

(b) Entiat Lake. Entiat Lake, created by Rocky Reach Dam at R.M. 473.6 on the Columbia River 7.5 miles north of Wenatchee, is 42 miles long and extends upstream to Wells Dam. The principal tributary to this reach of the Columbia is the Entiat River. The total surface area of this reservoir is 9,860 acres.

(c) Wanapum Reservoir. Wanapum Reservoir, created by Wanapum Dam at R.M. 415, 28 miles east of Ellensburg, is 38.3 miles long and extends upstream to Rock Island Dam. The total surface area of this reservoir is 14,680 acres, with a maximum depth of 121 feet.

(d) Priest Rapids Reservoir. Priest Rapids Reservoir, created by Priest Rapids Dam at R.M. 397, 29 miles east of Yakima, is 18 miles long and extends upstream to Wanapum Dam. The principal



COLUMBIA RIVER RESERVOIRS

FIGURE 4-1

tributary to this reach of the Columbia River is Crab Creek. The total surface area of this reservoir is 7,700 acres with a maximum depth of 88 feet.

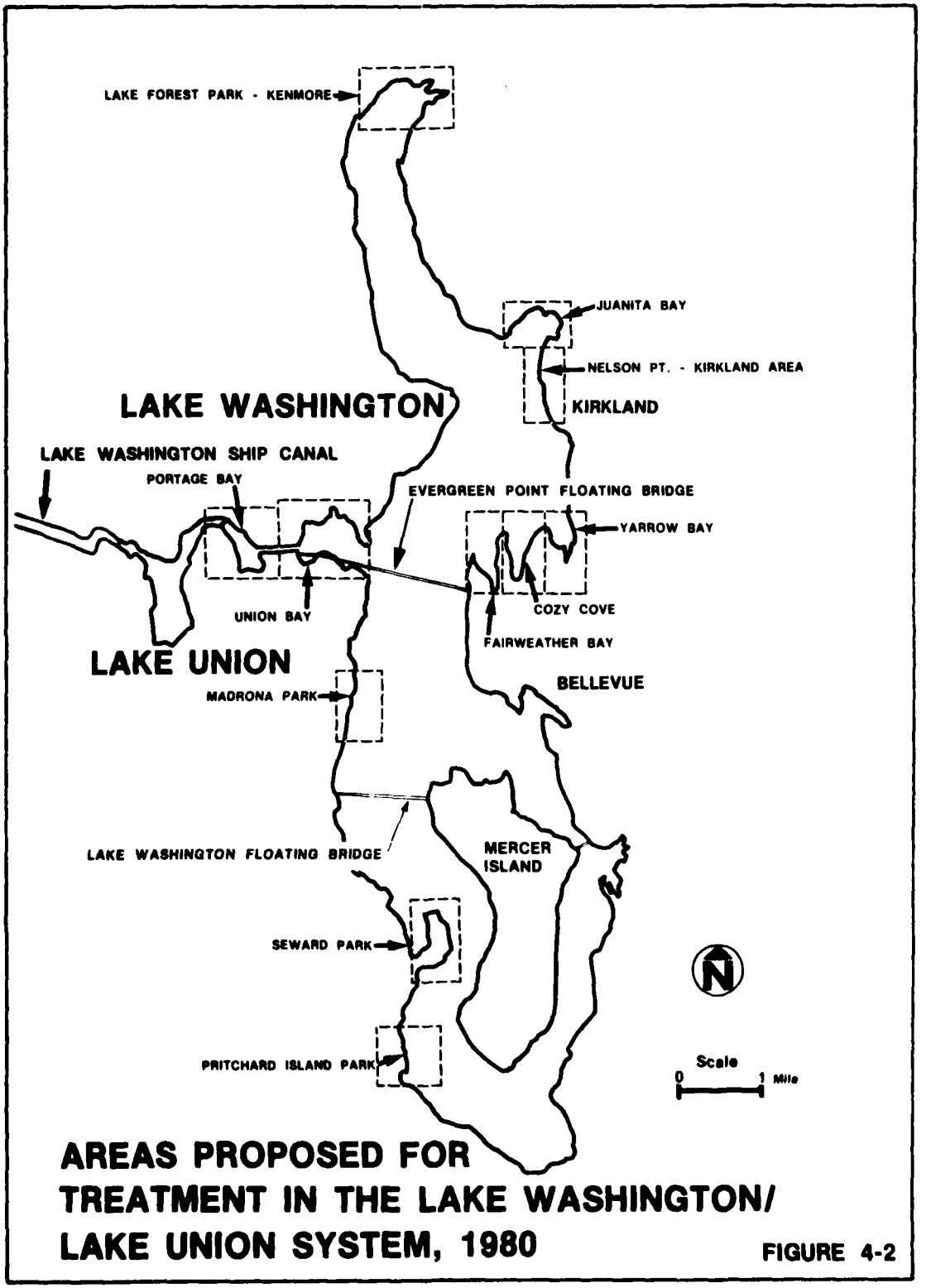
(4) Other Water Bodies. In addition to the specific sites, other sites may be identified through public input or agency surveillance and included in the 1980 prevention program.

b. Control Program. The proposed control program involves treating high-use public areas obstructed by milfoil in Lake Washington, Lake Union, and Lake Sammamish (see figures 4-2 and 4-3). A total of about 100 acres is proposed for treatment. The specific areas and acceptable treatment methods are described in the following paragraphs:

(1) Lake Washington. Lake Washington lies adjacent to the east side of Seattle. It is 19.5 miles long, with a total surface area of 22,138 acres, a maximum depth of 209 feet, and an average depth of 100 feet.

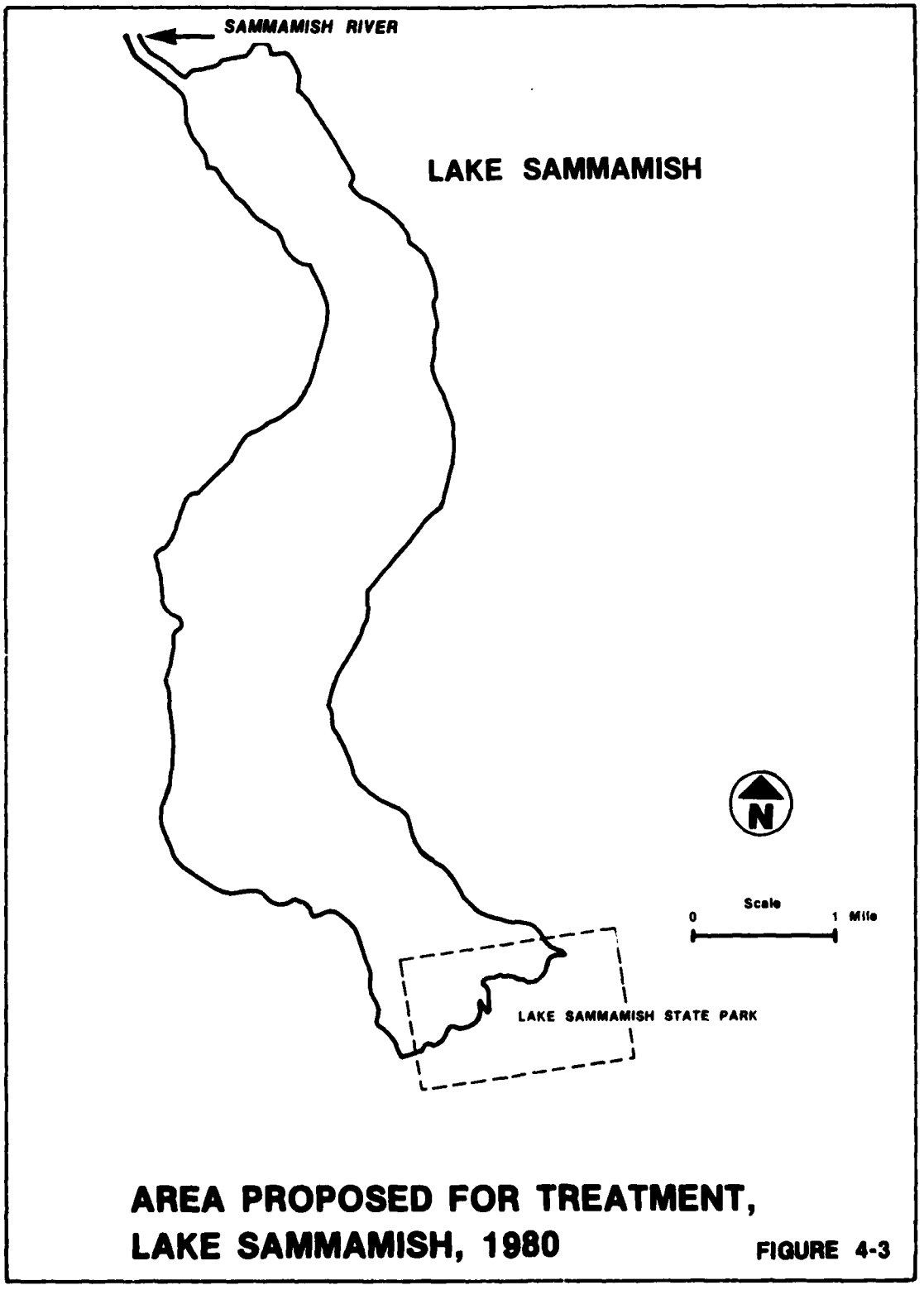
(a) Union Bay. Total surface area of Union Bay is approximately 350 acres. The total area infested with milfoil is estimated at 200 acres. Union Bay is a high-use area both for recreational boating and water-skiing and for commercial navigation, with the Lake Washington Ship Canal traversing the southern portion of the bay in an east-west direction. Within Union Bay, the proposal is to treat a 100-foot-wide channel in the high-use area along the shoreline of Webster Point, a distance of about 1,000 yards. The selection of a 100-foot-wide channel width is based on the objective of providing adequate navigation access while minimizing environmental impacts. In addition, 100-foot-wide channels in front of the University of Washington Yacht Club basin and boathouse and a 100-foot-wide channel on the south Union Bay shoreline fronting an apartment area, are proposed for treatment. The total treatment area is about 17 acres (see figure 4-4). Acceptable treatment for Union Bay includes the use of mechanical harvesting and/or the application of 2,4-D.

(b) Lake Forest Park-Kenmore. This area at the north end of Lake Washington contains approximately 250 acres, of which 100 acres are infested with milfoil. This is a high-use area for recreational boating, seaplane use, and commercial navigation. Barges bound for Alaska are loaded with cargo in this area. A county park and the Sammamish River inlet are also in this area. The proposed treatment involves a 100-foot-wide channel along the shoreline west of the King County Log Boom Park and south to about the Lake Forest Park Community Beach as shown in figure 4-5. This is a distance of about 800 yards. Additional treatment would be performed as required along the county park frontage to maintain full public use. The total treatment area is about 9 acres. Acceptable treatment for this area includes the use of mechanical harvesting and/or the application of 2,4-D. The treatment for swimming beach and park areas may also include the use of fiberglass bottom screens or the chemicals endothall, diquat, or dichlobenil.



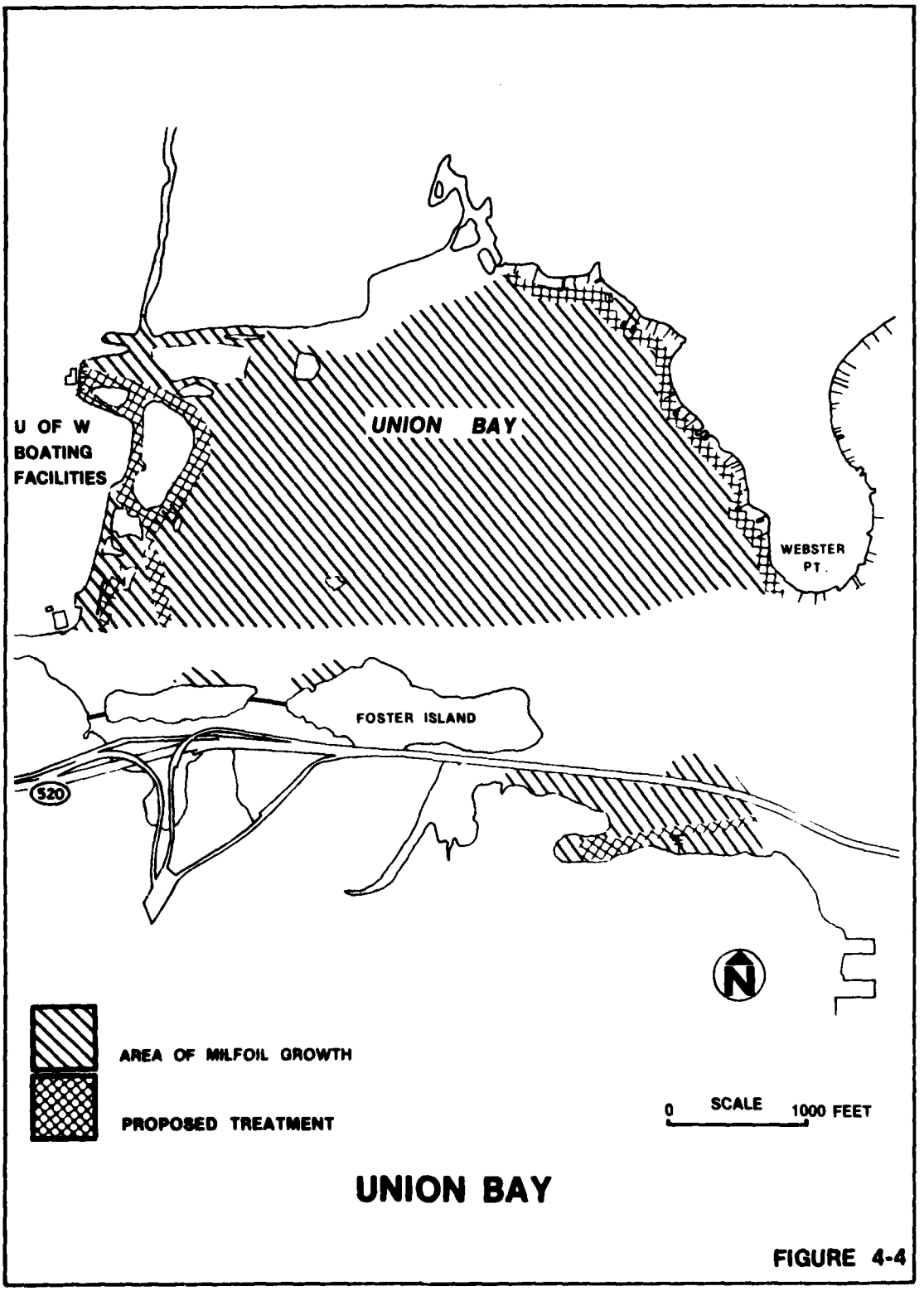
AREAS PROPOSED FOR TREATMENT IN THE LAKE WASHINGTON/ LAKE UNION SYSTEM, 1980

FIGURE 4-2



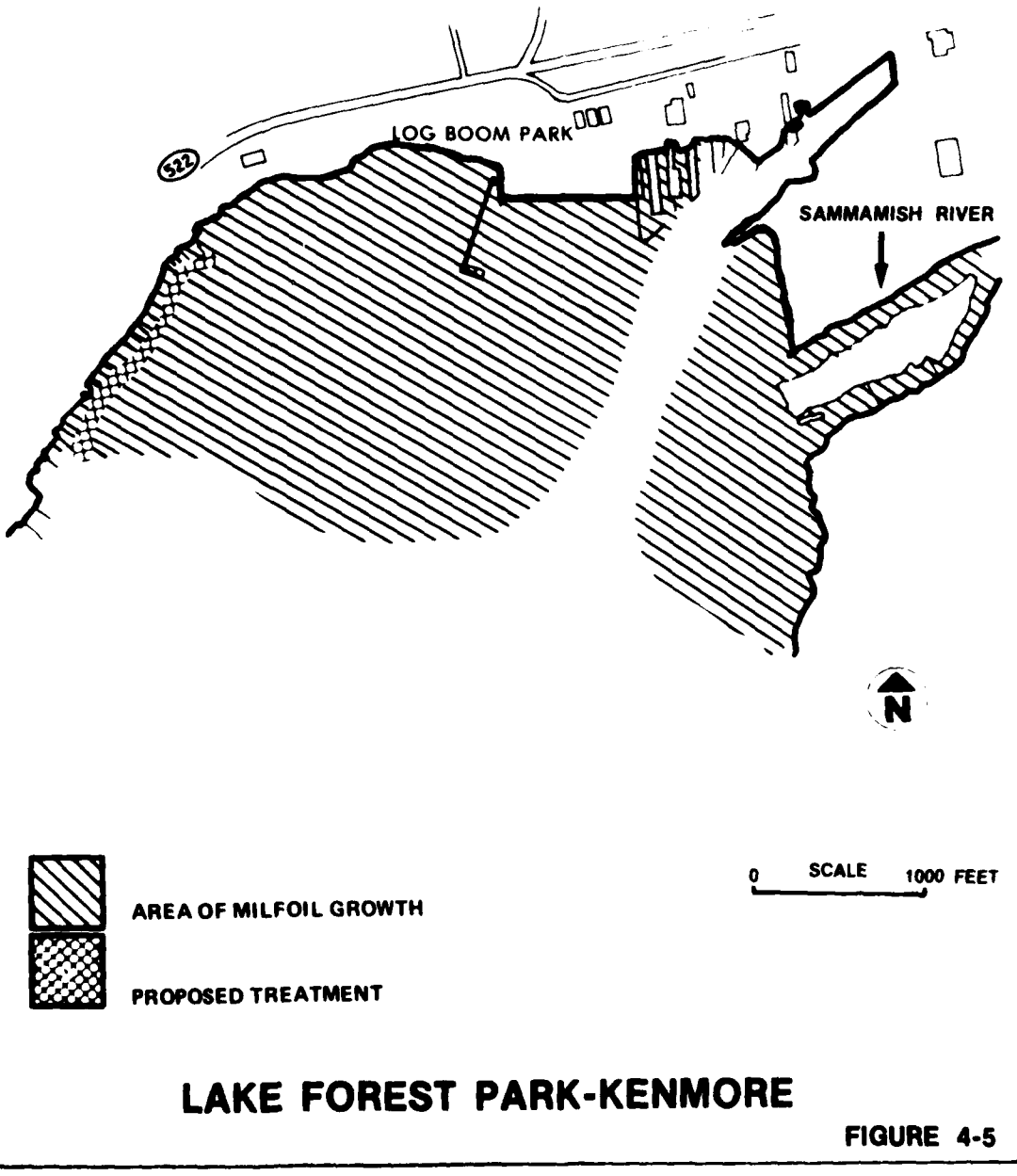
AREA PROPOSED FOR TREATMENT, LAKE SAMMAMISH, 1980

FIGURE 4-3



UNION BAY

FIGURE 4-4



LAKE FOREST PARK-KENMORE

FIGURE 4-5

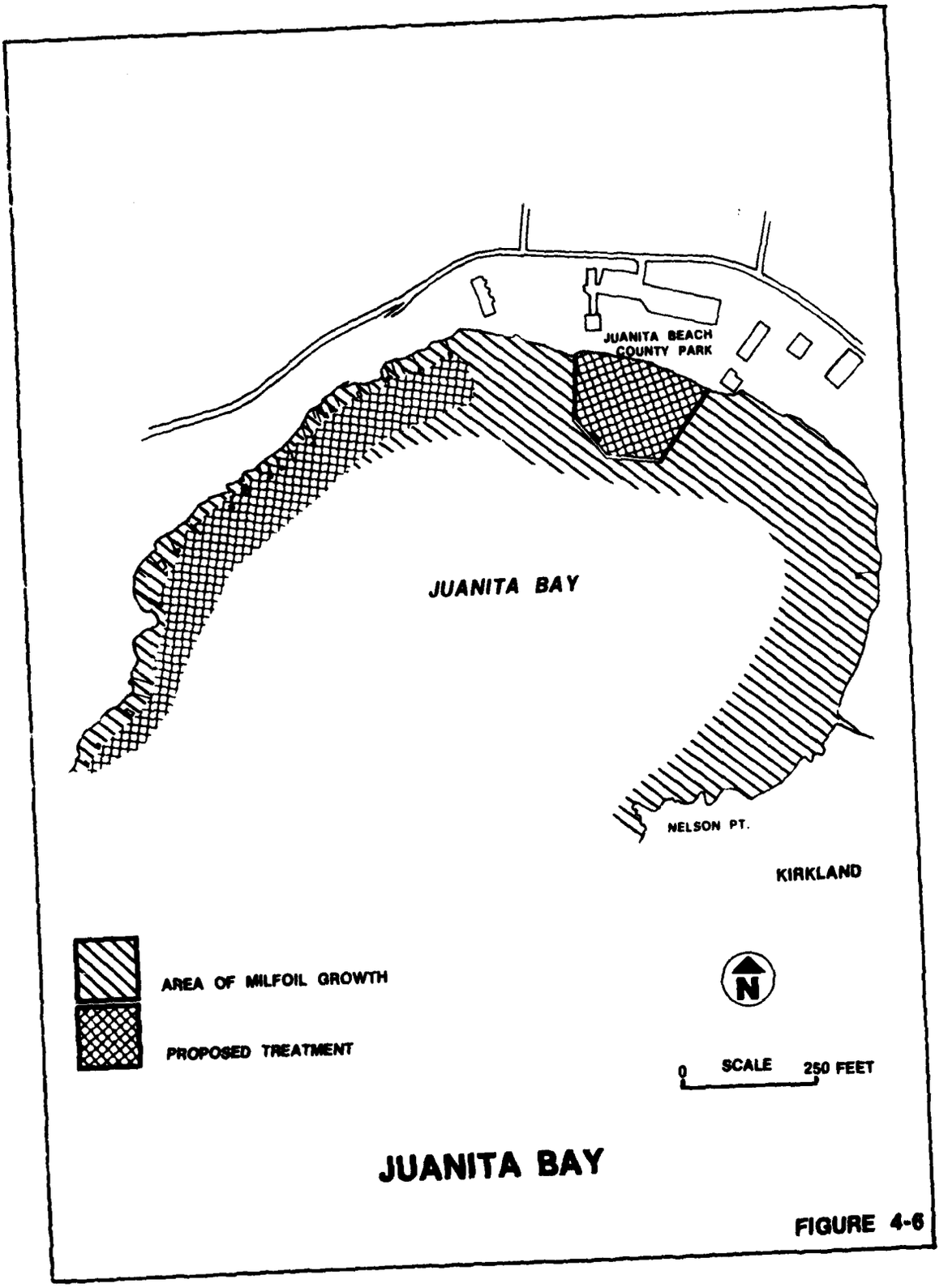
(c) Juanita Bay. Located on the east side of Lake Washington just north of Kirkland, this bay has a surface area of approximately 185 acres. About 50 acres are heavily infested with milfoil. This area receives relatively heavy usage from private boaters. Juanita Beach County Park, located here, is used heavily during the summer months. The proposal is to treat a 100-foot-wide channel along the shoreline in the high-use area (about 500 yards), as shown in figure 4-6, and treatment as necessary along the Juanita Beach County Park frontage to maintain full public use. The total treatment area is about 7 acres. Acceptable treatment for Juanita Bay includes the use of mechanical harvesting and/or the application of 2,4-D. The treatment for the swimming beach and park areas may also include the use of fiberglass bottom screens or the chemicals endothall, diquat, or dichlobenil.

(d) Nelson Point-Kirkland. This area is immediately south of Juanita Bay and contains approximately 50 acres that are heavily infested by milfoil. This is a relatively high-use area for boaters and water-skiers. The proposal is to treat a 100-foot-wide channel along 1,700 yards of shoreline in the high-use portion. This would involve about 12 acres (see figure 4-7). Acceptable treatment includes the use of mechanical harvesting and/or the application of 2,4-D.

(e) Yarrow Bay. Located on the east side of Lake Washington, it is the easternmost of three embayments in this area. All three lie between Kirkland on the north and Bellevue on the south, and at the eastern terminus of the Evergreen Point Floating Bridge (see figure 4-1). Yarrow Bay has a surface area of approximately 118 acres, of which about 25 acres are heavily infested. It receives heavy recreational usage from boaters, swimmers, and water-skiers. Within Yarrow Bay, the proposal is to treat a 100-foot-wide channel along the shoreline in the high-use areas as shown in figure 4-8. This includes about 900 yards of shoreline for a total area of about 6 acres. The acceptable treatment includes the use of mechanical harvesting and/or the application of 2,4-D.

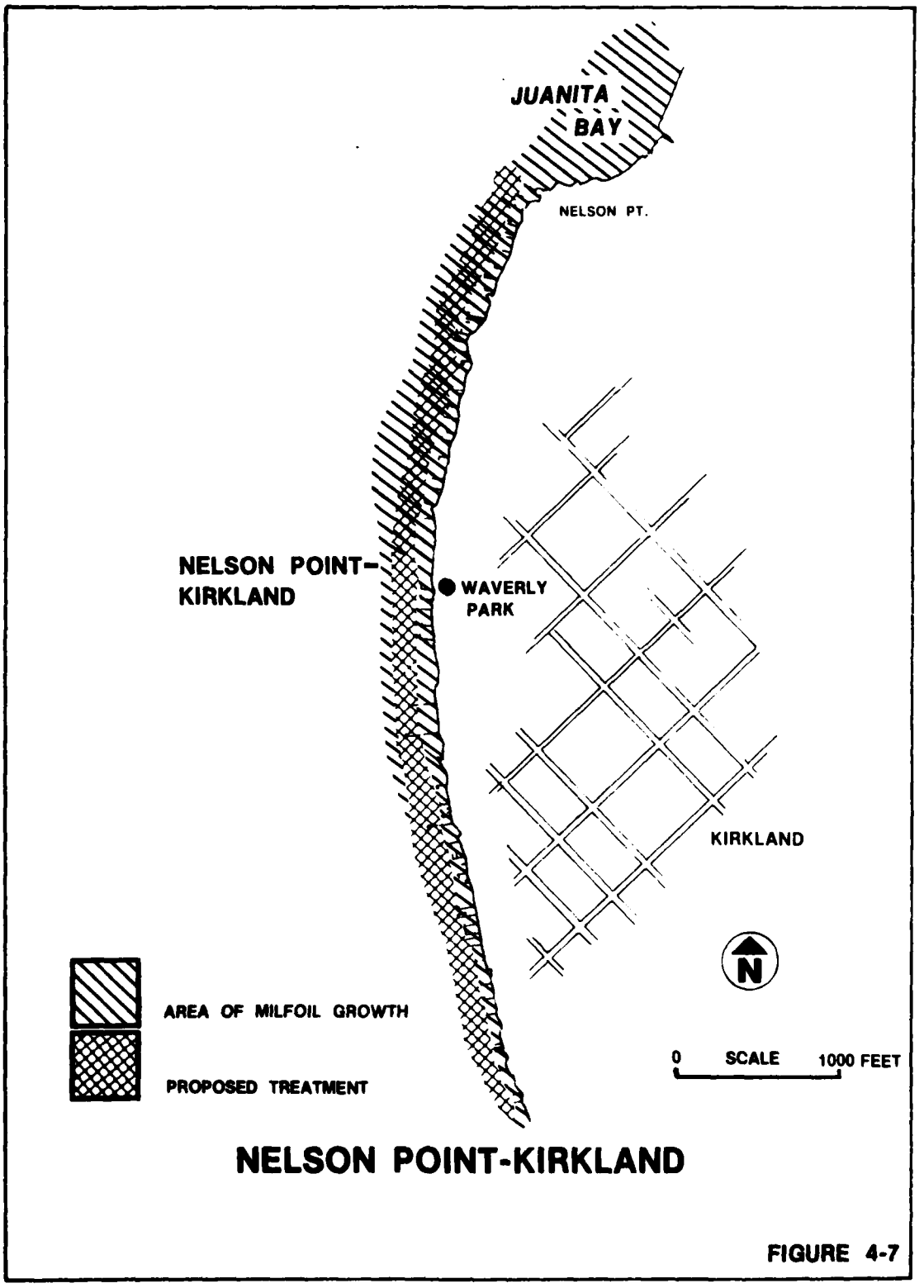
(f) Cozy Cove. Located just west of Yarrow Bay, Cozy Cove has a surface area of 205 acres, of which approximately 40 are infested with milfoil. Cozy Cove is also a high-use area with boating, swimming, and water-skiing as the major recreational uses. The proposal is to treat a 100-foot-wide channel along the shoreline in the high-use areas as shown on figure 4-9. This includes about 1,400 yards of shoreline for a total area of about 10 acres. Acceptable treatment includes the use of mechanical harvesting and/or the application of 2,4-D.

(g) Fairweather Bay. This is the westernmost of the three embayments with a surface area of about 87 acres. Approximately 40 acres are infested with milfoil. Fairweather Bay is also a high-use recreational area for boaters, swimmers, and water-skiers. The proposal is to treat a 100-foot-wide channel along two sections of the shoreline for a total distance of about 2,500 yards. The area



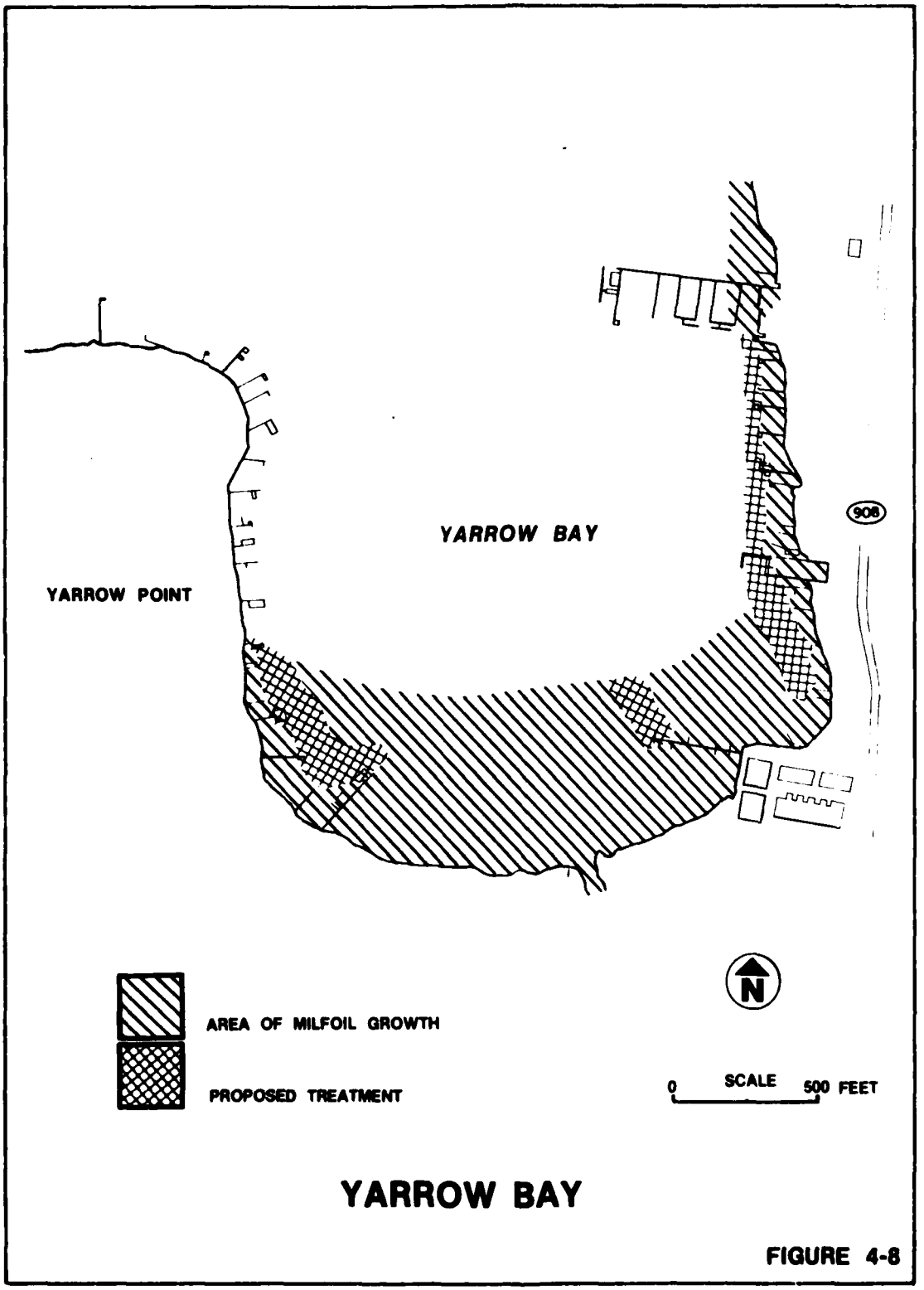
JUANITA BAY

FIGURE 4-6



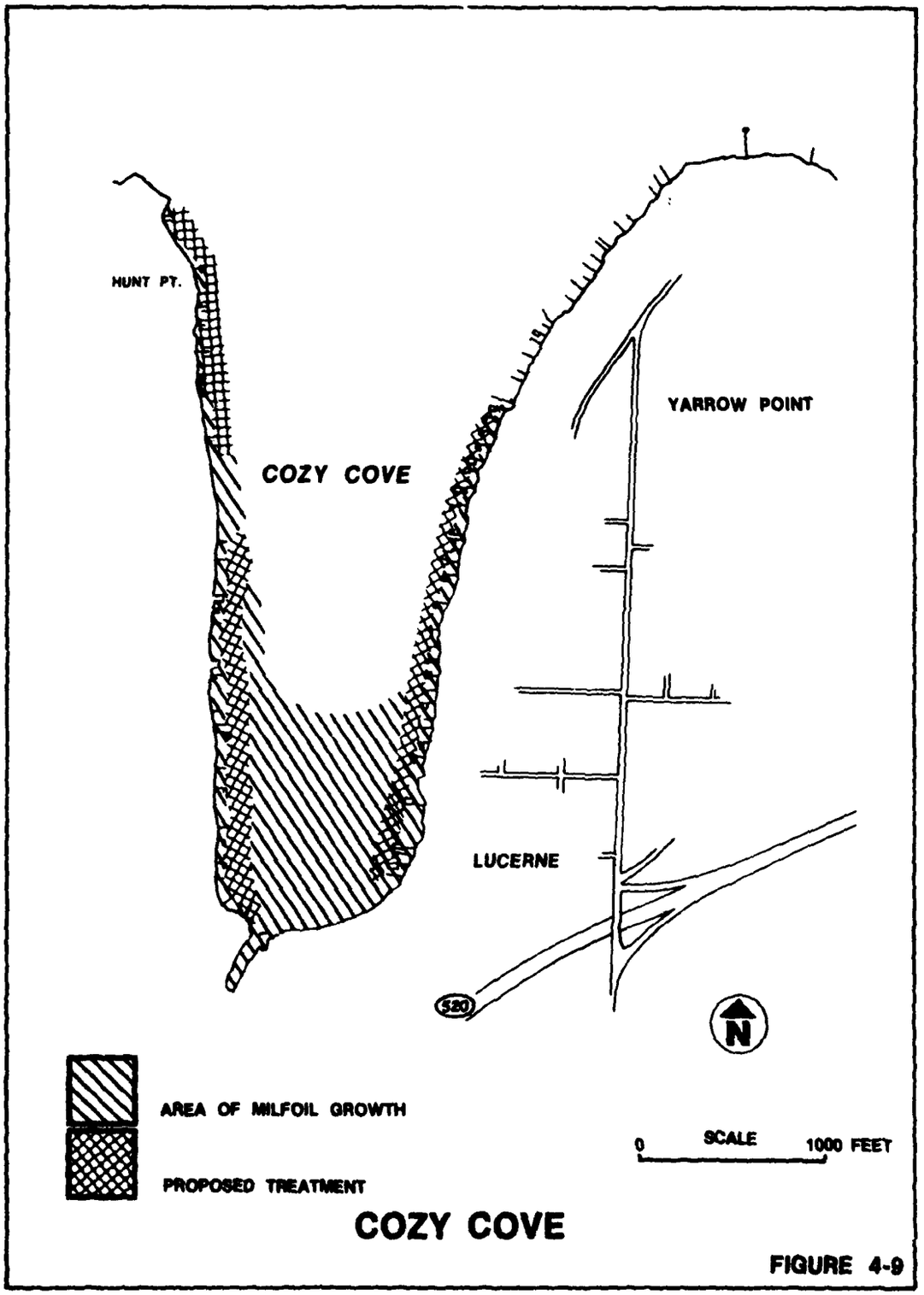
NELSON POINT-KIRKLAND

FIGURE 4-7



YARROW BAY

FIGURE 4-8



COZY COVE

FIGURE 4-9

involved is about 17 acres (see figure 4-10). Acceptable treatment includes the use of mechanical harvesting and/or the application of 2,4-D.

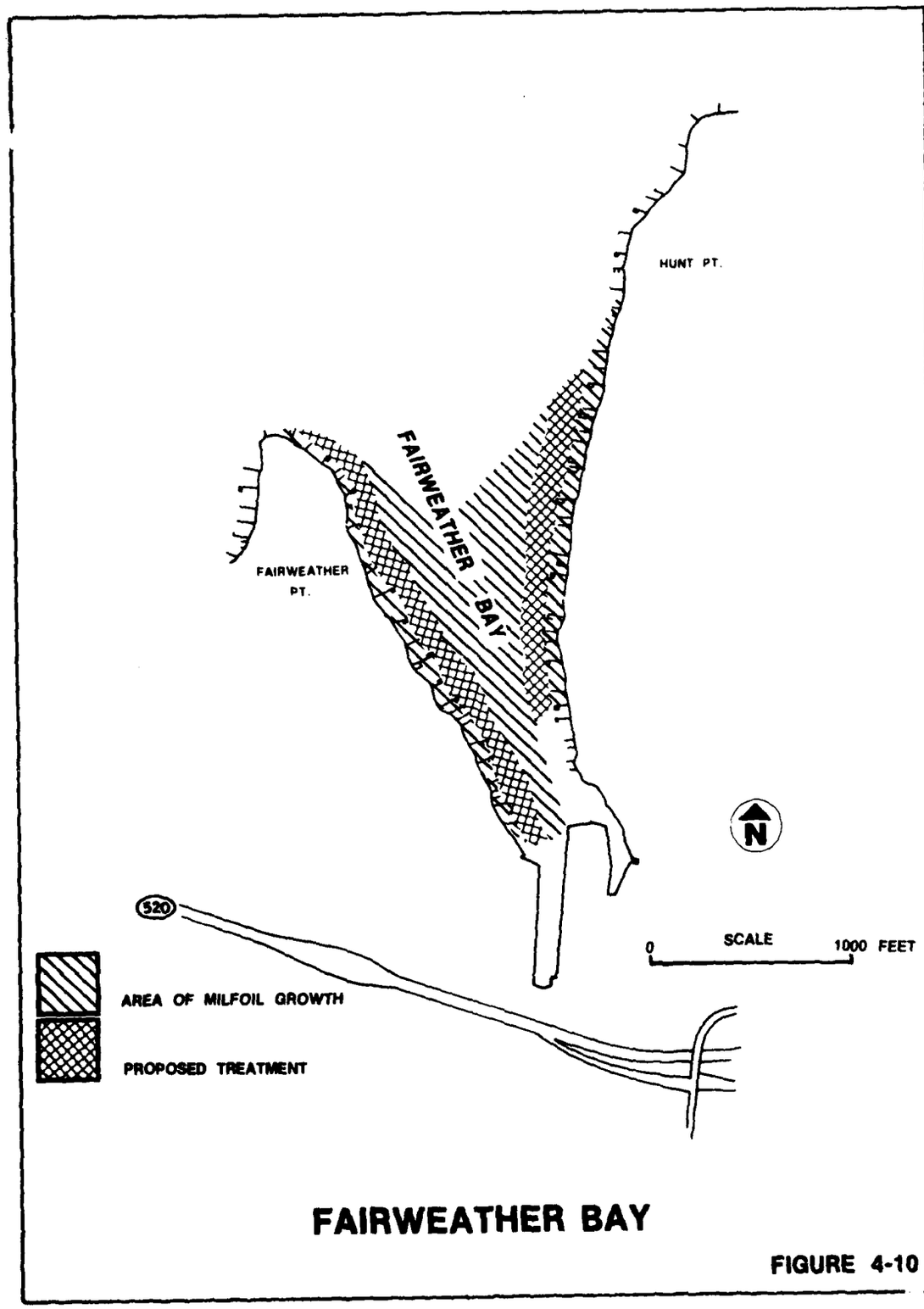
(h) Seward, Madrona, and Pritchard Island Parks. These three Seattle city parks are located on the west side of Lake Washington (see figure 4-2). The swimming beaches are primarily affected, and treatment would be limited to those areas of particularly heavy growth. Treatment of these beach areas would be done as necessary to maintain full public use. The acreage to be treated is roughly estimated at 2 acres. The acceptable treatment methods include the use of mechanical harvesting, fiberglass bottom screens, or the application of 2,4-D, endothall, diquat, or dichlobenil.

(2) Lake Union. Lake Union lies just west of Lake Washington and is fed by it through the Portage Cut. It has a total surface area of 646 acres, including Portage Bay, and a maximum depth of 54 feet. Portage Bay is the only area currently proposed for treatment in Lake Union. This is an area with very heavy usage from pleasure boats, University of Washington research boats, and commercial traffic. Of approximately 148 acres of surface area, about 45 acres are infested with milfoil. The proposal is to treat those portions of the existing infestation which particularly interfere with recreation boat use, including access to the navigation channel. The treated area would total about 14 acres (see figure 4-11). Acceptable treatment methods include the use of mechanical harvesting and/or the application of 2,4-D.

(3) Lake Sammamish. Lake Sammamish lies east of Lake Washington and discharges into it via the Sammamish River. It is 8 miles long with a total surface area of 4,897 acres and a maximum depth of 100 feet. The water fronting Lake Sammamish State Park is the only area on Lake Sammamish currently proposed for treatment. The State Park beach is very heavily used, as is the public boat launch area. The proposal is to treat public recreation areas as necessary to maintain full public use. This would include about 500 linear feet along the beachfront and an indeterminate distance in the boat-launch areas (see figure 4-12). The area involved is about 2 acres. Acceptable treatment methods include the use of mechanical harvesting, fiberglass bottom screens, or the application of 2,4-D, endothall, diquat or dichlobenil.

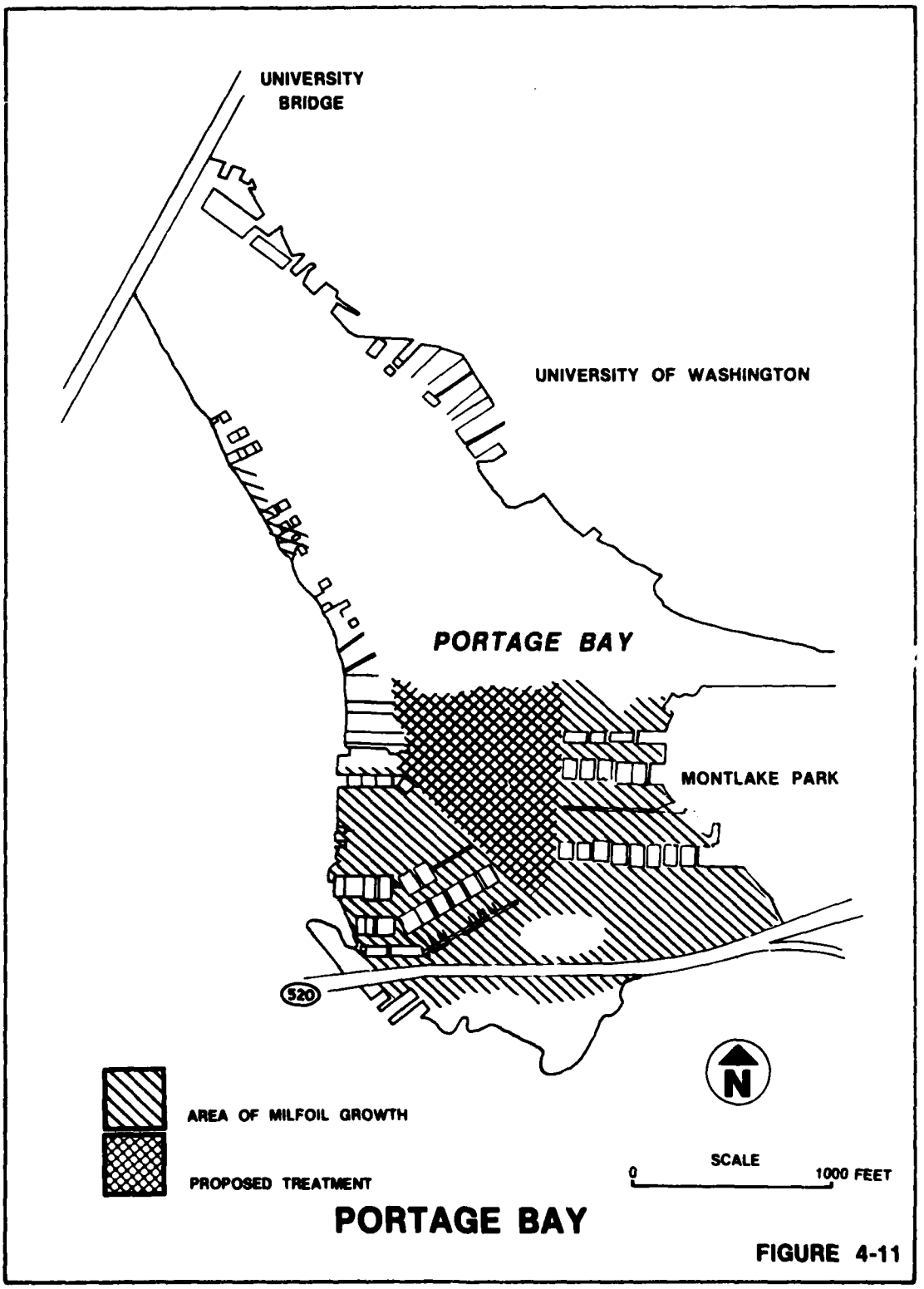
c. Monitoring and Evaluation.

(1) General. Monitoring and evaluation are necessary to determine the overall results of the aquatic plant management program and the effectiveness of controlling existing populations of milfoil and preventing its spread to uninfested navigable waters of Washington State. Monitoring is also necessary because of public concern over the use of chemicals for milfoil prevention and control. Monitoring and evaluation efforts have been developed such that responsibilities are shared by the Corps of Engineers and WDE.



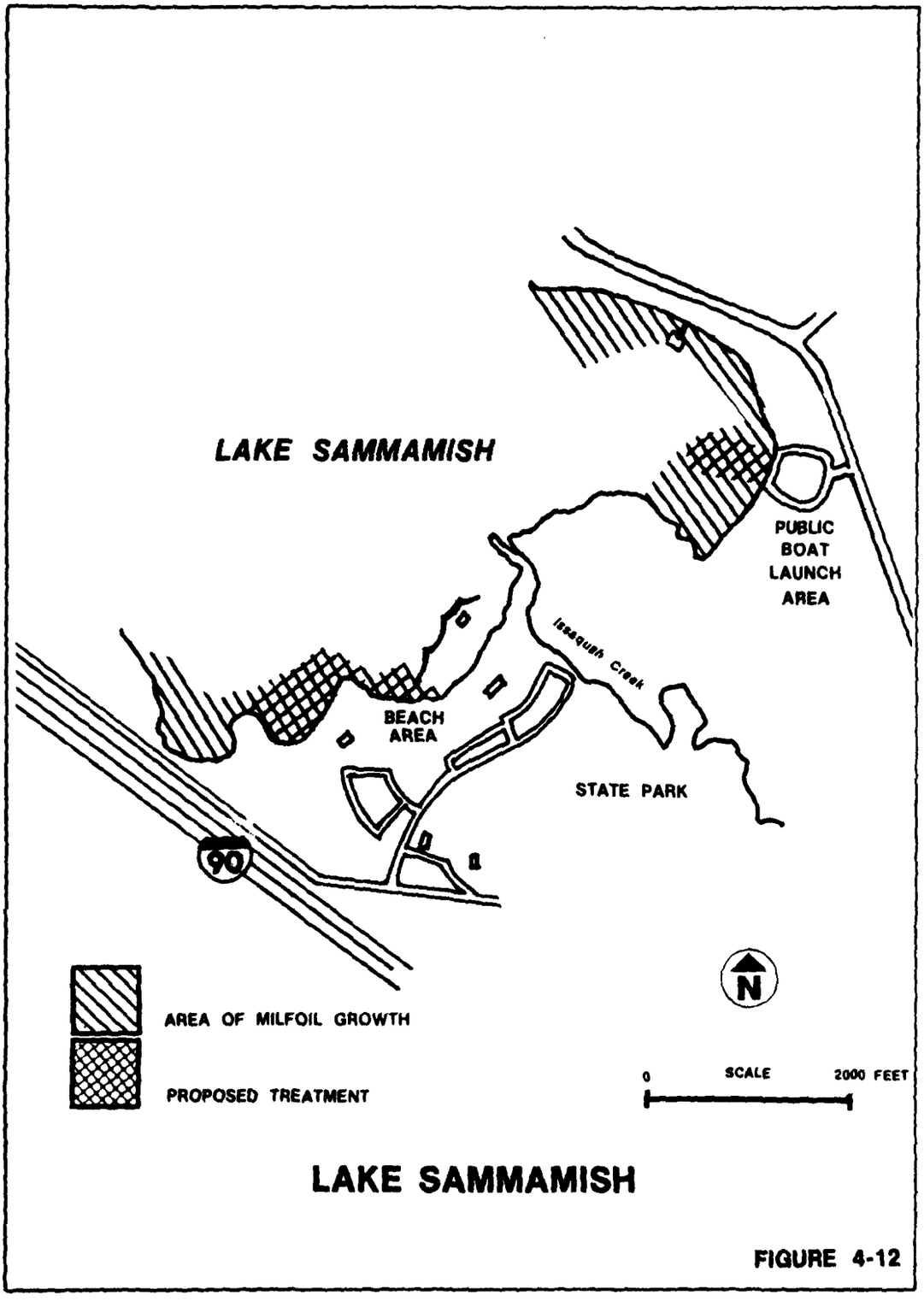
FAIRWEATHER BAY

FIGURE 4-10



PORTAGE BAY

FIGURE 4-11



LAKE SAMMAMISH

FIGURE 4-12

(2) Corps of Engineers. The Corps will annually evaluate the state-of-the-art of prevention and control measures. This evaluation will include a review of literature, including WES research, and coordination with other Corps of Engineers districts and other agencies. The Corps, in coordination with WDE, will also monitor the performance of the program, including effectiveness, costs of the treatment methods selected for use by local sponsors, economic justification, and, in the event of limited resources, the attention given to priorities of treatment.

(3) State of Washington.

(a) WDE will be responsible for evaluating the treatment site selections to ensure that:

- interested individuals, groups, and agencies are involved in the selection process;

- site selection is based on giving prevention measures a higher priority than control measures;

- sites are not located within authorized Federal projects;

- the site selected is in a navigable water of the United States and is infested to a degree which impairs recreational usage, navigation, flood control, drainage, agriculture, fish and wildlife, public health, hydropower, or related purposes, or in any other water body which may result in the infestation of navigable water;

- treatment of the proposed site will not result in an unacceptable impact to the environment; and

- the treatment methods selected by the local sponsors are one or a combination of those recommended by the Corps of Engineers.

(b) WDE will monitor and evaluate the cost and effectiveness of mechanical treatment measures. The effectiveness of mechanical control treatment measures will be monitored by comparison of the time which the treated area remains free from detrimental effects of milfoil with a standard time period range for that particular mechanical treatment method.

(c) WDE will ensure that the contractor applying chemicals for the treatment of milfoil is certified by all applicable local, state, and Federal licensing agencies. The cost of a unit of area treated will be monitored by comparison with a standard cost range for a unit of treatment area. At selected sites, WDE will monitor milfoil treatment to determine whether the actual concentrations of herbicides in the water, following milfoil treatment, are compatible with the label descriptions specifying persistence. Samples will be taken before, during, and after application. The degree of drift of

the herbicides will also be monitored where necessary. The effectiveness of chemical treatment measures will be monitored, including the percentage of root kill resulting from treatment, and the selectivity of the plant kill.

(d) The Washington State Department of Agriculture is responsible for monitoring the application rate of herbicides used by contractors to ensure that quantities of herbicides are applied according to the label instructions.

(e) In the event that monitoring detects greater concentrations of a herbicide in a water body than specified on a manufacturer's label, site-specific information relative to the herbicide treatment (i.e., application rate, persistence, etc.) will be examined to determine whether modifications to future treatment measures are necessary. Also, data needs at the treatment site would be evaluated to determine whether modifications in the scope of future monitoring measures would be necessary in conjunction with subsequent herbicide treatments.

(f) WDE will monitor and evaluate public awareness of treatment methods used through the use of interviews, questionnaires, and coordination with the public affairs offices of the Corps of Engineers' Seattle District and WDE.

(g) WDE will periodically make projections of future milfoil growth and compare these projections with actual infestation levels.

(h) WDE will provide the Corps of Engineers with the results of the monitoring and evaluation program and also make the results available to the public on request.

4.03 Impact Assessment.

a. Mechanical Harvesting. Mechanical harvesting will result in exhaust emissions from the harvester and from trucks required to transport the harvested plants to disposal sites. This will have an impact upon air quality. There may be increased noise and traffic if haul trucks are used. These impacts should be minor and of short duration.

Mechanical harvesting will have a positive effect on esthetic values by preventing milfoil from growing to the surface and forming unsightly mats which tend to collect debris. By removing part of the biomass from the water, it will decrease the volume of milfoil washing up and decomposing on the shore in the fall.

The effects of mechanical harvesting on water quality will be beneficial. Large-scale harvesting of aquatic plants is a method for slowing the eutrophication of lakes. By removing harvested milfoil from the water, its bound nutrients are taken out of the normal cycle and are, therefore, unavailable to fuel further aquatic plant or algae growth. Also, the biochemical oxygen demand normally associated with aquatic plant decay will be reduced due to the reduction of milfoil biomass in the water.

Mechanical harvesting involves cutting the milfoil above the substrate. The harvester is nonselective; any other aquatic vegetation present will be cut at the same level. Dense stands of milfoil tend to shade out other species, so harvesting may have a beneficial effect on native species.

The removal of the upper portion of aquatic vegetation by mechanical harvester will eliminate habitat for a variety of aquatic microflora and fauna, aquatic invertebrates, and shelter for small fish. The harvesters cut above the substrate so a certain amount of habitat remains. The aquatic vegetation will regrow after harvesting.

b. Rotovating. The impacts upon air quality, noise levels, and traffic caused by rotovator operation will be basically the same as those caused by mechanical harvesting.

There will be short-term adverse impacts on esthetics related to the disruption of the substrate. Water turbidity will be greatly increased and silt could be deposited on the beach during operations in soft bottom areas.

Benthic communities will be physically disrupted and suspended substrate particles will resettle on benthic organisms and aquatic vegetation. Nutrients and any other chemicals in the sediment will be mixed with the water column. The nutrients will be available to stimulate growth of aquatic plants and algae. Resuspended chemicals could have significant impacts upon water quality, depending on what and how much, is present in the sediment.

Rotovating generally removes the entire plant so the milfoil will not grow back from the root crown. Rotovation is totally nonselective; any nontarget plant species in the treatment area will also be removed. Elimination of aquatic vegetation will result in a loss of aquatic habitat. Milfoil and other aquatic species could eventually reinfest the area if fragments float in from other colonies.

c. Suction Dredge. Because of the small scale of work to be done by the suction dredge, there will be no significant environmental impacts.

d. Hand Removal. There will be no significant environmental impacts associated with hand removal, since this method would only be used on a very limited scale.

e. Chemical Control (2,4-D, Endothall, Dichlobenil, and Diquat). Use of chemicals will provide a forum for bringing together different groups of people with diverse attitudes. The ensuing discussions may be disruptive to the community because of the differing sets of values of each group.

Chemical control of milfoil will have the same beneficial impacts on esthetics as those noted for mechanical harvesting. Milfoil will be

stressed during the growing season and have less biomass prior to winter dieback. There should be no adverse impacts on esthetics.

Decreased water quality is possible when chemical treatment is used to control milfoil. The milfoil dies and begins to decompose in a relatively short time, creating a large biochemical oxygen demand. The decomposition of milfoil requires a 1-to-1 ratio of free oxygen to organic matter. Since milfoil can produce over 10,000 pounds of biomass per acre, the decrease in dissolved oxygen could be significant if proper treatment procedures are not used. Chemical control operations could result in chemical drift into nontreatment areas. The amount of drift would vary depending on current, rate of uptake by plants, and the chemical formulation used. Impacts to the drift areas will be the same as to the treatment areas.

Organic and inorganic phosphorus are released into the water column during the decomposition of milfoil. Since the amount of phosphorus present is often the limiting factor for plant growth in many water bodies, a chemical milfoil kill may result in rapid growth of other aquatic plants or algae.

The persistence of aquatic herbicides in the water column is dependent on metabolic breakdown by microorganisms, extent of dilution, water depth, water temperature, etc. Generally, these chemicals do not remain in the water at high concentrations. A longer retention period could occur in the sediments.

At the proposed concentrations, 2,4-D is selective for milfoil and would not affect most of the native species of aquatic plants. Endothall, diquat, and dichlobenil, however, are not selective at the proposed concentrations and would eliminate a wide range of native species.

Relatively low concentrations of 2,4-D may be toxic to salmonids. The toxicity is dependent upon species and chemical formulation, but treatment should avoid high-use areas during spawning, rearing, and migration.

Any of the chemical alternatives could cause damage to upland plant species if treated water were used for irrigation not in accord with label instructions. Chemical treatment of aquatic plants will eliminate significant habitat for a variety of aquatic microflora and fauna, aquatic invertebrates, and shelter for small fish. A long-term, large-scale program could decrease fish populations due to the elimination of food organisms.

The long-term impacts of low-level herbicide exposure to public health is not known for 2,4-D, endothall, diquat, or dichlobenil. Adverse effects to humans resulting from concentrations required for the control of milfoil have never been reported. These herbicides have been shown to have adverse effects on laboratory animals at varying concentrations. Although still subject to debate, there is

some indication that 2,4-D acts as a cocarcinogen in laboratory animals and causes developmental anomalies. There are no swimming, water-skiing, or fishing label restrictions required following application of 2,4-D. Therefore, there is a potential for human exposure to low levels of 2,4-D. However, based upon the results of monitoring, the public would be advised when the concentration in treated areas had reached an established acceptable intake level of 0.1 ppm (World Health Organization criteria). Chronic toxicity would not be a problem because the maximum human exposure would be to a low concentration for a short time each year.

f. Fiberglass Bottom Screen. Due to the small areas involved, the use of fiberglass screen for bottom shading will have no significant impacts on the environment. All native plants under the screen will be eliminated.

g. Fragment Barriers. An adverse impact to esthetics and navigation will result from a barrier spanning a waterway. The visual impact will be increased by the accumulation of debris at the barrier.

h. Aerial and Ground Surveillance. No significant impacts are expected to result from the surveillance program. Minor impacts to air quality caused by exhaust emissions from surveillance vehicles will occur.

i. Public Information. Significant impacts are expected to result from the public information program in that the public will become more aware of milfoil presence, potential problems, and means to prevent its spread.

4.04 Mitigation. Chemical treatment will not be used as a milfoil control measure during migration and spawning periods of salmon. Coordination will be maintained with the Washington State Department of Fisheries to develop and implement necessary procedures to minimize impacts on fishery resources. U.S. Fish and Wildlife Service recommendations and Seattle District responses are found in appendix C.

4.05 Cost Estimates. Estimated program costs, summarized below, are found in appendix A. All costs are based on unit prices at October 1979 price levels.

a. Prevention Program. The 1980 prevention program costs are based upon statewide efforts of surveillance; public awareness and training; and spot treatments in Osoyoos Lake, Okanogan River, four Columbia River reservoirs (Wells, Entiat, Wanapum, and Priest Rapids), and other water bodies containing pioneer milfoil colonies. Cost components are:

Surveillance	$90,000
Treatment	30,000
Public Awareness	10,000
Training	5,000
Monitoring and Evaluation	7,000
Reporting	4,000
Supervision and Administration	54,000
TOTAL	$200,000

b. Control Program. The 1980 control program costs are based upon treating approximately 100 acres in Lakes Washington, Union, and Sammamish. If all of the areas were treated by the use of 2,4-D (low cost alternative), the cost would be $76,000. If fiberglass bottom screens were used at swimming beaches and mechanical harvesting in all other areas (high cost alternative), the cost would be $192,000.

	Low Cost	High Cost
Treatment	$17,500	$151,500
Monitoring and Evaluation	33,000	3,000
Supervision and Administration	25,000	37,500
TOTAL	$76,000	$192,000

c. Overall Costs. Estimated costs of the first year aquatic plant management program are summarized in table 4-1.

TABLE 4-1

SUMMARY OF ESTIMATED COSTS
(October 1979 Price Levels)

	Treatment Method	
	Low Cost	High Cost
Prevention Program	$200,000	$200,000
Control Program	76,000	192,000
TOTAL COSTS	$276,000	$392,000
Federal Cost (70 percent)	$193,000	$274,000
Non-Federal Cost (30 percent)	$83,000	$118,000

4.06 Benefit Analysis. The analysis of benefits is found in appendix B. The basic assumptions made in determining benefits are:

- recreation losses are claimed only for the three summer months of June, July, and August, during which beaches are officially open for swimming;

- an estimated 50 percent loss in swimming opportunity will occur due to milfoil growth; and

• an estimated 35 percent loss in beach activity will occur due to milfoil presence.

a. Prevention Program. Average annual benefits over a 100-year period of economic analysis are estimated at $772,000. Benefits are based on the prevention of recreation loss of swimming and beach activity. No recreation benefits are claimed for swimming or beach activity within the Rock Island Reach of the Columbia River because no potential for milfoil infestation has been identified in this area or on the Okanogan River because there are no known public recreation sites. Estimated prevention program benefits are shown below.

Swimming	$412,000
Beach Activity	360,000
TOTAL	$772,000

b. Control Program. Average annual benefits are estimated at $625,000. These benefits accrue from swimming, beach, and boating activities which, without a control program, would be lost annually.

Swimming	$320,000
Beach Activity	266,000
Boating (General)	39,000
TOTAL	$625,000

c. Overall Benefits. Total estimated average annual benefits are summarized in table 4-2.

TABLE 4-2

SUMMARY OF ESTIMATED BENEFITS

Prevention Program	$772,000
Control Program	625,000
TOTAL	$1,397,000

4.07 Benefit-to-Cost Comparison.

a. Overall Program. Total benefits for the program are estimated at $1,397,000. First year costs for the combined prevention and control programs are $276,000 for lowest cost treatment and $392,000 for highest cost treatment. The resulting benefit-to-cost ratios are 5.1 to 1 and 3.6 to 1, respectively.

b. Prevention Program. Average annual benefits, based on a 100-year period of analysis and 7-1/8 percent interest, are estimated at $772,000. The first year cost, including supervision and administration, is estimated at $200,000. The benefit-to-cost ratio is 3.9 to 1.

c. Control Program. Benefits for the first year of the control program are estimated at $625,000. The first year cost for the control program, including monitoring, administration, and supervision, is estimated to range from $76,000 to $192,000. The resultant benefit-to-cost ratios range from 8.2 to 1 to 3.2 to 1, respectively.

4.08 Schedule and Funding.

a. Future Program. This design memorandum develops a first year program for Fiscal Year (FY) 1980 (October 1979 to September 1980). Beyond FY 1980, if milfoil growth declines, the program would taper off. If the problem continues, the program could be expanded through coordinated efforts of local and state governments and the Corps of Engineers. Local governments, with the Department of Ecology, will develop an annual statewide work plan for submittal to the Corps of Engineers. The Corps will prepare annual supplements to this design memorandum to be used for requesting approval for changes in the program and submitting budgetary requests. The Corps of Engineers and WDE will sign a cooperative agreement for the purpose of administratively operating the program within the guidelines of the design memorandum. The draft cooperative agreement is found in appendix E.

b. Treatment Operations. Chemical control program activities are most effective when accomplished during May, June, and July when initial milfoil growth is taking place. Mechanical harvesting should be done when sufficient biomass is available for cutting. Fiberglass bottom screens can be placed any time during the year, but it is easier in early spring when plants are small. Siltation should also be considered in deciding how long to leave screens down. Most prevention program activities can be carried out any time during the year, but spot treatment of areas with chemicals are most effective during May through July. Coordination with the Washington State Department of Fisheries will be done to identify salmon migration routes and spawning areas and schedule any treatment activities accordingly.

c. Funding.

TABLE 4-3

FISCAL YEAR 1980 FUND REQUIREMENTS

	Treatment Methods	
	Low Cost	High Cost
Federal (70 percent)	$193,000	$274,000
Non-Federal (30 percent)	83,000	118,000
TOTAL	$276,000	$392,000

4.09 Local Cooperation. Implementation of the aquatic plant management program is contingent upon the participation of a sponsor. The WDE has agreed by letter dated 4 April 1979 to act as the "umbrella" sponsor for the program (see exhibit 3 of appendix C). The program would be administered in accordance with the terms of a cooperative agreement between the WDE and the Corps of Engineers. The WDE is required to work with local government and agencies who will be expected to contribute to the prevention and control operations within their political jurisdiction. The local cooperation requirements contained in the authorizing legislation are shown below:

- Hold and save the United States free from claims that may occur from prevention and control operations.

- Participate to the extent of 30 percent of the cost of prevention and control operations.

SECTION 5. CONCLUSIONS AND RECOMMENDATIONS

5.01 Conclusions. I have reviewed the proposed aquatic plant management program in light of the overall public interest, as well as the stated views of the interested agencies and the concerned public as expressed through correspondence, public meetings, and workshops. My review has included an examination of alternative treatment methods for control of Eurasian watermilfoil in Washington State. Possible consequences of these alternatives have been studied in view of technical, economic, environmental, and other considerations of public interest.

5.02 Eurasian watermilfoil is a problem in several lakes, rivers, and reservoirs in eastern Washington and the Puget Sound area of western Washington. It has curtailed recreation activities in these areas and has the potential of decreasing water quality and land values and impacting hydropower production, fish and wildlife, irrigated agriculture, and public health.

5.03 We have studied a number of alternatives ranging from no action to complete eradication. Doing nothing would jeopardize maintaining the clean waters of Lakes Washington, Sammamish, and Union and would allow milfoil growth to establish in the Columbia River and other uninfested water bodies. Total eradication of firmly established milfoil populations would not be successful unless a means could be found to prevent milfoil from coming into the state. A program which provides flexibility in selecting treatment methods and sites and which will prevent milfoil growth from reaching major proportions appears to be the best alternative.

5.04 We have investigated a number of alternative treatment methods to control milfoil growth. In this regard, we have consulted with Federal and state agencies with expertise and past experience. I have concluded the following treatment methods are acceptable for use:

- Mechanical harvesting
- Fiberglass bottom screens
- Rotovating
- Hand removal
- Suction dredging
- Fragment barriers
- 2,4-D
- Diquat
- Endothall
- Dichlobenil

The final decision of what treatment method, or combination of methods, is used should be made by the Washington State Department of Ecology and the local governments that participate in the program.

5.05 Concerning the importance, relative to overall public use and benefit, of the sites recommended for treatment, I have concluded

that areas to be treated and other related activities should be assigned in the following priorities:

Priority 1 (Prevention Program)

Water bodies where the detection and treatment of Eurasian watermilfoil will prevent its spread to navigable waters within the State of Washington.

Priority 2 (Prevention Program)

Public information and education throughout the State of Washington to inform citizens of the presence of Eurasian watermilfoil, the potential problems posed by the plant, and measures to prevent spread of the plant.

Pricrity 3 (Control Program)

Public-use areas (such as swimming beaches or boat launch ramps) located on navigable waters.

Priority 4 (Control Program)

Other public high-use areas in navigable waters (such as connecting channels to open waters for boaters).

5.06 I find that the proposed aquatic plant management program is based on a thorough analysis and evaluation of all practical alternative courses of action for achieving the stated objectives. The proposed action is consistent with national policy and, on balance, the total public interest would be best served by implementation of the proposed aquatic plant management program.

5.07 Recommendations. I recommend that an aquatic plant management program for Washington State be approved substantially as described in this report at an estimated Federal first year cost not exceeding $274,000 (70 percent of $393,000) provided that, prior to initiation of prevention and control program operations, the State of Washington enters into a cooperative agreement with the Corps of Engineers to administer the program and agrees to:

- hold and save the United States free from claims that may occur from the prevention and control operations carried out under the program; and

- participate to the extent of 30 percent of the costs of the program through local agreements or in-kind contributions.

MAREY B. CARPENTER, JR.
Lt. Colonel, Corps of Engineers
Acting District Engineer

appendix a

COST ESTIMATES

APPENDIX A

COST ESTIMATES

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1. Treatment Methods. Costs for the various treatment methods are based on October 1979 price levels and include the contractor's cost, the administrative cost of local government ($2,000 per treatment), Washington Department of Ecology (WDE) supervision and Corps of Engineers management. The contractor cost does not include obtaining necessary permits. WDE administrative costs vary according to each treatment method because all pass-through funds are assessed 7 percent for WDE costs. Local administration and Corps management costs are estimated based upon the staff necessary to accomplish the work, including an allowance for overhead. The annual costs are based on the treatment of 100 acres.

The proposed program is for 1 year only. Even though there are provisions for continuing the program into subsequent years, all costs have been estimated based on a 1-year program. Accordingly, all program costs incurred are payable in the first year. For instance, fiberglass bottom screen is not presently available for rental in the greater Seattle area and, therefore, the full purchase price must be included in the first year costs even though the screen has a useful life of more than 1 year.

a. Mechanical Harvesting. The costs of mechanical harvesting are based upon the rental rate of available equipment in the Seattle area. The estimated per-acre cost is:

Harvester Rental[1/]	$480
Disposal Cost	50
Contingencies (10 percent)	50
Local Administration[2/]	40
WDE Supervision[3/]	190
Program Evaluation	30
Corps Management[4/]	80
Total Cost/Acre	$920

1/Cost for one treatment, which involves two cuttings during the growing season, includes labor, maintenance, profit, capitalization of equipment costs, and mobilization-demobilization.

2/Local administrative costs are $2,000 for 100 acres. In the case of mechanical harvesting, two cuttings are involved, so the total local administration cost is $4,000 for 100 acres.

3/40 percent of 1 man-year plus $1,000 travel plus 7 percent of pass-through funds.

4/20 percent of 1 man-year plus travel plus preparation of annual design memorandum supplement.

b. Rotovating. Rotovating would be used for spot treatments in the prevention program and a definite cost per acre was not estimated. Based upon the Canadian aquatic plant management program, costs in the range of $600 to $700 per acre, plus a capital cost of $50,000 could be expected.

c. Suction Dredge. Suction dredging would be used for spot treatment in the prevention program so a definite cost per acre was not estimated. Based on the Canadian program, costs in the range of $800 to $900 per acre, plus a capital cost of $12,000 could be expected.

d. Hand Removal. Hand removal of milfoil could be practical in areas of limited growth. In shallow water this can be accomplished by hand pulling with no special equipment; in deeper water it would require diving gear and specially trained personnel. The cost of this method, which would be based principally on labor and the cost of diving equipment, if required, would be entirely dependent on the situation. The use of this method would be minimal and very localized. No per-acre cost has been estimated because of lack of data and limited probable use of this method.

e. Chemical Treatment. For chemical treatment, the per-acre cost includes:

- one treatment boat with crew;
- one chase boat with crew (used to keep people out of treatment area);
- a four-man shore support crew (used for public notification and any necessary loading and unloading);
- the cost of herbicides;
- contingencies (including alternate source of domestic water supply and variations in chemical costs, labor, equipment, and monitoring and evaluation);
- Federal, state, and local administration and supervision;
- Aquatic plant community and water chemistry monitoring and program evaluation;
- Profit.

(1) 2,4-D (DMA Liquid). Liquid 2,4-D (DMA) would be applied at a rate of 5 gallons per acre in areas where the water depth is 4 feet or less, and 10 gallons per acre where the water is deeper than 4 feet. The per-acre costs are:

Chemical Costs	$100
Labor and Equipment[1/]	45
Contingencies (25 percent)	35
Local Administration	20
WDE Supervision	160
Monitoring and Evaluation	330
Corps Management	80
Total Cost/Acre	$770

(2) 2,4-D (BEE Granular). Granular 2,4-D (BEE) would be applied at a rate of 100 pounds per acre. The per-acre cost is:

Chemical Costs	$ 85
Labor and Equipment[2/]	55
Contingencies	35
Local Administration	20
WDE Supervision	155
Monitoring and Evaluation	330
Corps Management	80
Total Cost/Acre	$760

(3) Diquat. Diquat would be applied at a rate of 2 gallons per acre. The per-acre cost is:

Chemical Costs	$115
Labor and Equipment	45
Contingencies	40
Local Administration	20
WDE Supervision	160
Monitoring and Evaluation	330
Corps Management	80
Total Cost/Acre	$790

1/Labor and equipment costs are based on $3,000/day for labor, the rental of two boats at a cost of $64/day each, mobilization-demobilization of equipment, and a capability of treating 100 acres/day.

2/The treatment boat can handle 8,000 pounds a day. Based on the weight of chemical used per acre, the treatment capability would be 80 acres/day.

(4) Endothall (Liquid). Liquid endothall would be applied at a rate of 10 gallons per acre. The per-acre cost is:

Chemical Costs	$245
Labor and Equipment	45
Contingencies	70
Local Administration	20
WDE Supervision	170
Monitoring and Evaluation	330
Corps Management	80
Total Cost/Acre	$960

(5) Endothall (Granular). Granular endothall would be applied at a rate of 500 pounds per acre. The per-acre cost is:

Chemical Costs	$460
Labor and Equipment[1/]	210
Contingencies	165
Local Administration	20
WDE Administration	205
Monitoring and Evaluation	330
Corps Management	80
Total Cost/Acre	$1,470

(6) Dichlobenil. Dichlobenil would be applied at a rate of 150 pounds per acre. The per-acre cost is:

Chemical Costs	$435
Labor and Equipment[2/]	80
Contingencies	130
Local Administration	20
WDE Supervision	190
Monitoring and Evaluation	330
Corps Management	80
Total Cost/Acre	$1,265

f. Fiberglass Bottom Screen (Polyvinyl Chloride Coated Fiber-Glass Screen). The cost of fiberglass bottom screen is based on purchase and installation because fiberglass screen is not presently available for rental in the greater Seattle area. The per-acre cost is:

1/Based on the weight of chemical used per acre, the treatment capability would be 16 acres/day.

2/Based on the weight of chemical used per acre, the treatment capability would be 50 acres/day.

Fiberglass Screen[1/]	$9,900
Local Administration	20
WDE Supervision	840
Program Evaluation	30
Corps Management	80
Total Cost/Acre	$10,870

2. Program Monitoring and Evaluation. The costs estimated for evaluation and monitoring of the Aquatic Plant Management Program that are separable from local administration, WDE supervision, and Corps management costs are listed below:

	Low-Cost (Chemical) Program	High-Cost (Mechanical) Program
Persistence and drift tests to monitor chemical treatment at three sites.	$20,000	0
Percentage of root kill analysis from chemical treatment at three sites.	3,000	0
Selectivity of plant kill by transect analysis at representative treatment sites.	4,000	0
Program evaluation 2/.	9,000	$9,000
Contingency	4,000	1,000
Total Annual Costs	$40,000	$10,000

3. Prevention Program. Activities in the prevention program are undertaken to keep milfoil from establishing or reaching levels that obstruct desired usage. Generally, major effort is in surveillance because of the need for intensive and frequent collection of ground data supplemented by aerial reconnaissance. Spot treatment is minimal due to the small areas occupied by pioneer colonies. Following are descriptions of the work activities in each component of the first year prevention program.

1/Cost is based on a purchase and installation price of $0.21 per square foot and 10 percent contingencies.

2/Program evaluation includes a literature search for state-of-the-art information; treatment site selection evaluation; treatment method selection evaluation; and monitoring treatment methods in terms of cost, effectiveness, and public acceptance. Of the total $10,000 ($9,000 plus 10 percent contingency) for evaluation, $7,000 is chargeable to the prevention program and the remainder to the control program.

- Surveillance. This includes aerial photo missions, ground truth surveys to verify presence of suspected milfoil colonies, localized surveys of potential milfoil sources, and evaluation of data. $90,000

- Treatment. This includes spot treatment of pioneer milfoil colonies for the purpose of preventing movement to other areas where new colonies would be established. Treatment methods will be one of the following: rotovating, hand removal, suction dredging, fragment barriers, or 2,4-D. The primary prevention area is in eastern Washington (Osoyoos Lake, Okanogan River, and Columbia River). Specific areas to be treated have not been identified because the potential for spread has to be determined. However, the total area is estimated to be less than 20 acres. Operation and maintenance of fragment barriers on the Okanogan River at Oroville are also included. 30,000

- Public Awareness. All activities are directed to informing the public of the potential problems caused by milfoil and what actions can be taken to prevent milfoil from reaching major problem proportions in the state. Activities include public workshops, newspaper articles, brochures, signs, television and radio announcements, and special notices (e.g. in aquarium shops). 10,000

- Training. Activities consist of workshops and field instruction to produce personnel well-trained in implementing prevention program procedures. Subjects to be covered include plant identification, survey of commercial outlets that could be selling milfoil, documentation of survey activities, field orientation, treatment methods, and reporting procedures. 5,000

- Monitoring and Evaluation. Monitoring consists of persistence and drift tests, root kill analysis, and selectivity of plant kill by transect analysis at selected treatment sites. Evaluation consists of cost and effectiveness analysis of the overall program, including state-of-the-art review. 7,000

- Reporting. Compilation of the separate elements of the prevention program will be accomplished with discussion on methods for improving the overall effectiveness. This information will provide input to the annual design memorandum supplement. 4,000

• Supervision and Administration. This includes Department of Ecology ($22,000)[1/] and Corps of Engineers ($32,000)[2/] administration and management costs for the prevention program. $54,000

TOTAL $200,000

4. Control Program. The areas designated for treatment in the 1980 control program in western Washington total approximately 100 acres. The actual cost of the 1980 control program will be dependent upon the combination of treatment methods employed. The highest cost involves the use of a mechanical harvester in all areas except beaches, where fiberglass bottom screens would be used. The lowest cost program involves the use of 2,4-D (BEE) in all areas. The highest and lowest costs are:

Low-Cost

2,4-D (BEE granular) 100 acres	$ 8,500
Labor and Equipment	5,500
Contingencies	3,500
Monitoring and Evaluation	33,000
Local Administration	2,000
WDE Supervision	15,500
Corps Management	8,000
TOTAL	$76,000

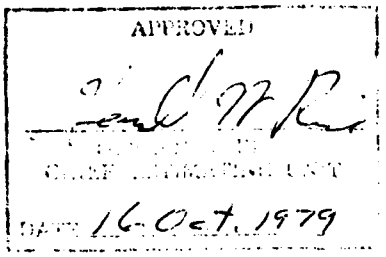
High-Cost

Mechnical Harvesting 90 Acres @ $530/Acre[3/]	$ 47,700
Fiberglass Bottom Screens 10 acres @ $9,000/Acre[4/]	90,000
Contingencies	13,800
Monitoring and Evaluation	3,000
Local Administration	4,000
WDE Supervision	25,500
Corps Management	8,000
TOTAL	$192,000

1/Based on 60 percent of 1 man-year plus travel.
2/Based on 80 percent of 1 man-year plus travel, including annual design memorandum supplement.
3/Includes labor, equipment rental, and disposal of harvested milfoil.
4/Includes purchase and installation.

5. Annual Aquatic Plant Management Program Costs. The estimated costs for the Aquatic Plant Management Program are tabulated below:

	Low Cost	High Cost
Prevention Program	$200,000	$200,000
Control Program	76,000	192,000
TOTAL	$276,000	$392,000
Federal Share	$193,000	$274,000
Non-Federal Share	$83,000	$118,000



appendix b

BENEFIT ANALYSIS

APPENDIX B

DETAILED BENEFIT ANALYSIS

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FIGURES

1. General. Benefits creditable to the Aquatic Plant Management Program in Washington State are derived from consideration of the loss of water-related recreation opportunities, and from the fact that private property owners are willing to assume the cost of eliminating milfoil obstructions to recreation. Benefits have been evaluated separately for the control and prevention programs.

2. Control Program. Economic justification for the control program is based on preventing recreation loss (swimming and beach activity) and on th public's willingness to pay for elimination of milfoil hazards. Total economic benefits are estimated at $625,000 in 1980, the first year of the control program. Each year thereafter, as the scope of the control program is modified, attributable benefits will be redetermined.

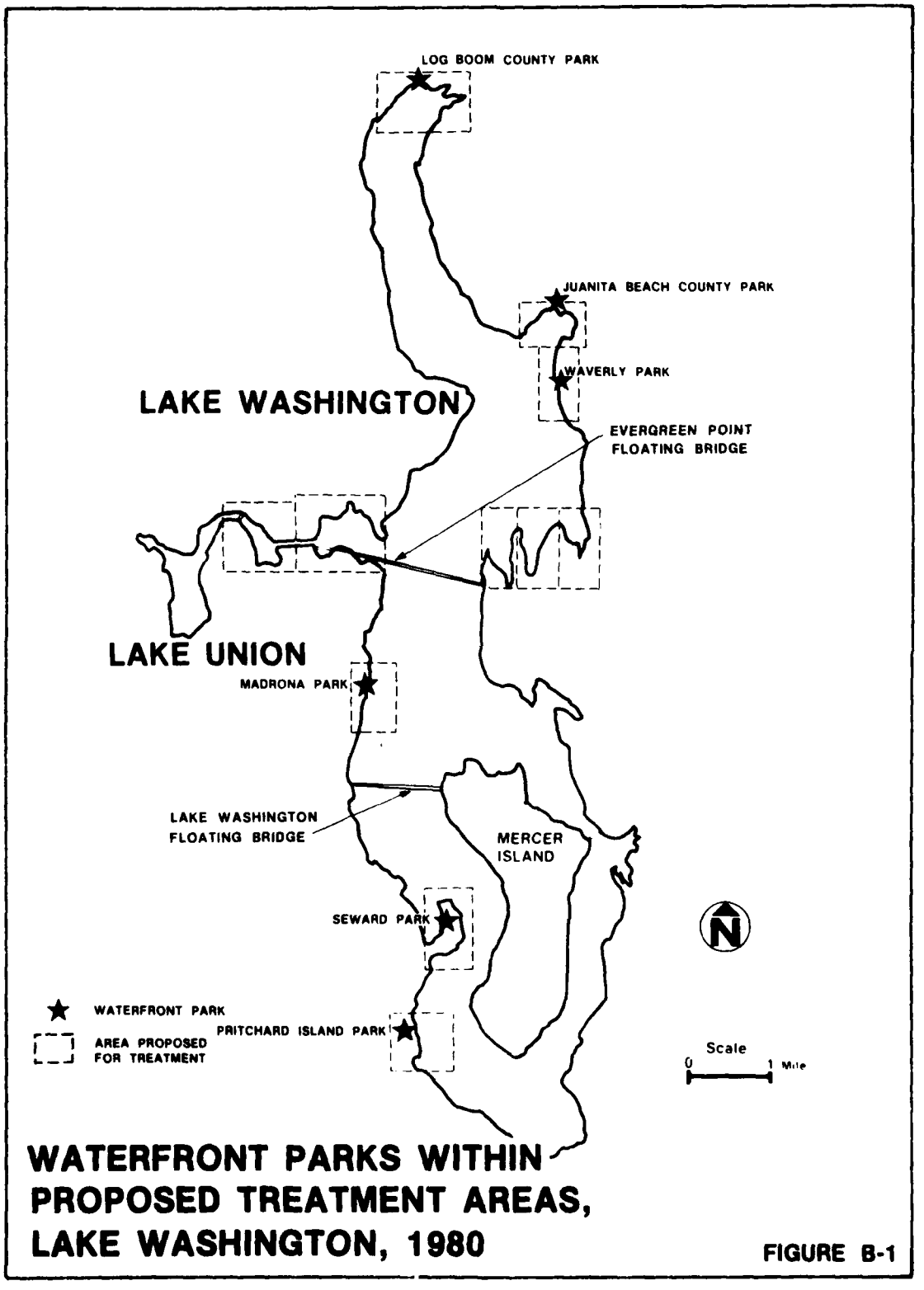
3. Economic benefits accrue from swimming and beach activity which, without a control program, would be lost annually because of encroachment of milfoil. A precedent for swimming beach closure due to milfoil encroachment was established when the swimming beach at Steamboat Rock State Park in eastern Washington was closed by the Washington State Parks Commission in 1978.

4. It cannot be accurately predicted that swimming beaches will be uniformly or simultaneously impacted by milfoil encroachment. Therefore, a 50 percent loss in swimming participation has been estimated. The economic analysis is based on the assumption that all swimming beaches will be impacted by milfoil growth, but that none will be closed to public use by park officials. Because encroaching milfoil reduces open-water areas suitable for swimming, a very real deterrent to swimming at control program beaches will be present. The Washington State Parks Commission and other responsible agencies are expected to place certain restrictions on swimming, including the posting of signs warning of the presence of milfoil.

5. In addition, a 35 percent loss in beach activity participation, which includes sunbathing, playing games, picnicking, sightseeing, and other leisure activities, is claimed. A similar level of reduction in beach activity participation was noted at Steamboat Rock State Park in 1978 following closure of the swimming beach due to milfoil infestation.[1/]

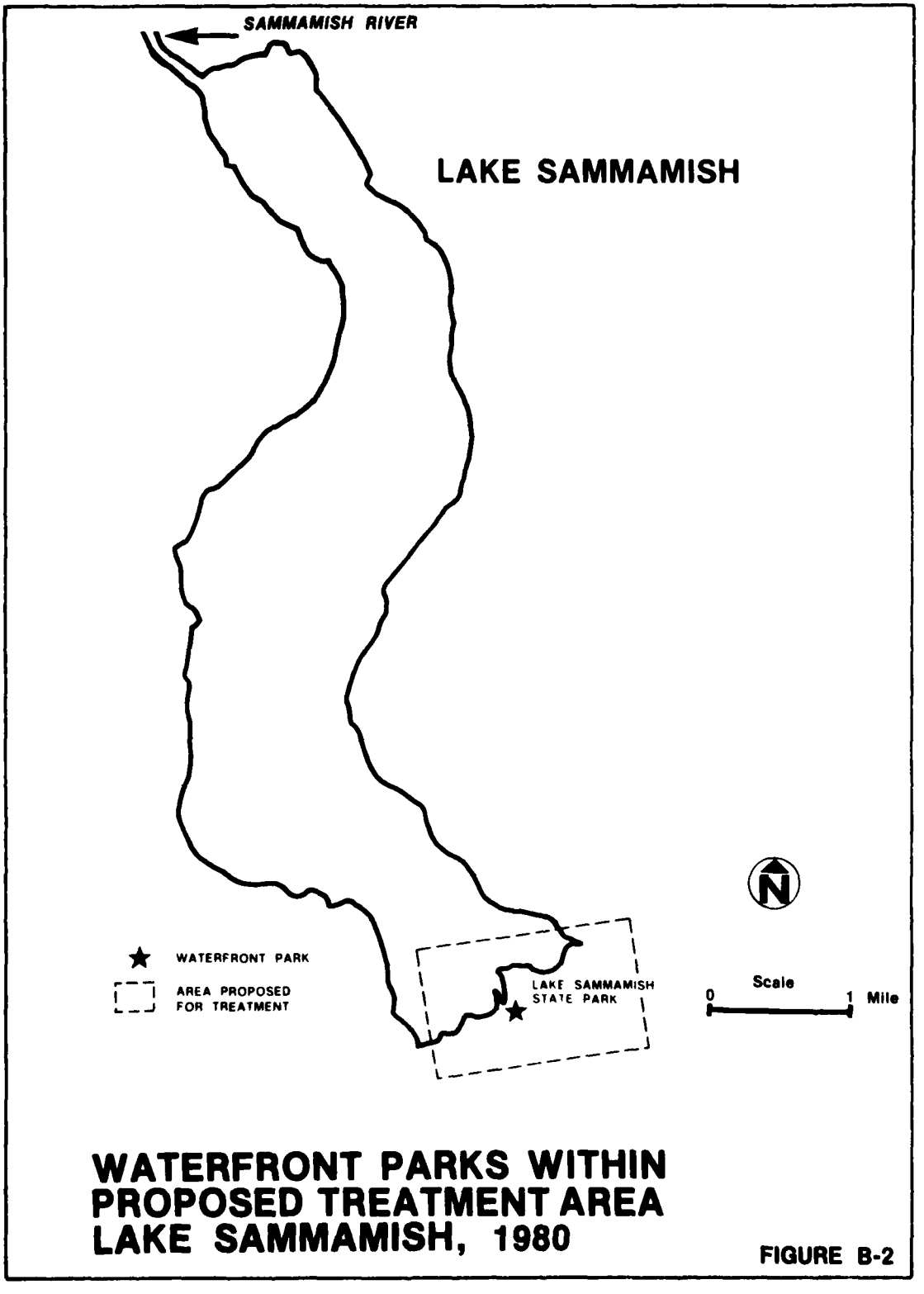
6. Seven waterfront parks within the Lake Washington-Lake Sammamish system have been identified as having milfoil infestations and are included in areas of the proposed 1980 control program (see figures B-1 and B-2). Swimming and beach activities at these parks during

1/Telecommunication on 17 April 1979 with Mr. Gary Herron, Park Manager, Steamboat Rock State Park, Electric City, Washington.



WATERFRONT PARKS WITHIN PROPOSED TREATMENT AREAS, LAKE WASHINGTON, 1980

FIGURE B-1



WATERFRONT PARKS WITHIN PROPOSED TREATMENT AREA LAKE SAMMAMISH, 1980

FIGURE B-2

the summer of 1978 is tabulated in table B-1. To calculate the economic benefits that would accrue from the control program, the summer swimming and beach activity, measured in recreation activity,[1/] has been projected to 1980 levels [2/] with and without a control program (see table B-2).

TABLE B-1

CONTROL PROGRAM AREAS
SUMMER SWIMMING AND BEACH ACTIVITY
(JUNE, JULY, AND AUGUST) - 1978

Waterfront Park	Recreation Activity	
	Swimming	Beach Activity
Madrona Park	8,296	10,695
Seward Park	5,465	6,984
Pritchard Island Park	4,201	7,113
Waverly Park	5,942	8,913
Juanita Beach County Park	23,878	26,201
Logboom County Park	3,878	11,829
Lake Sammamish State Park	256,680	293,577
TOTAL ACTIVITIES	308,340	365,312

SOURCE: Park and recreation departments of the city of Seattle, King County, and the State of Washington.

TABLE B-2

CONTROL PROGRAM AREAS
PROJECTED SUMMER SWIMMING AND BEACH ACTIVITY - 1980

With Control Program	Recreation Activity	
	Swimming	Beach Activity
Total Control Program Area	320,308	379,491
Without Control Program		
Total Control Program Area	160,154	246,669
RECREATION LOSS	160,154	132,822

1/A "recreation activity" is a measure of recreation use consisting of a visit by one individual to a recreation site, area, or project for recreation purposes during all or any portion of a 24-hour day. May consist of several activity days.

2/Based on the projected rate of increase of swimming activity occasions in King County calculated by the Washington State Interagency Committee for Outdoor Recreation.

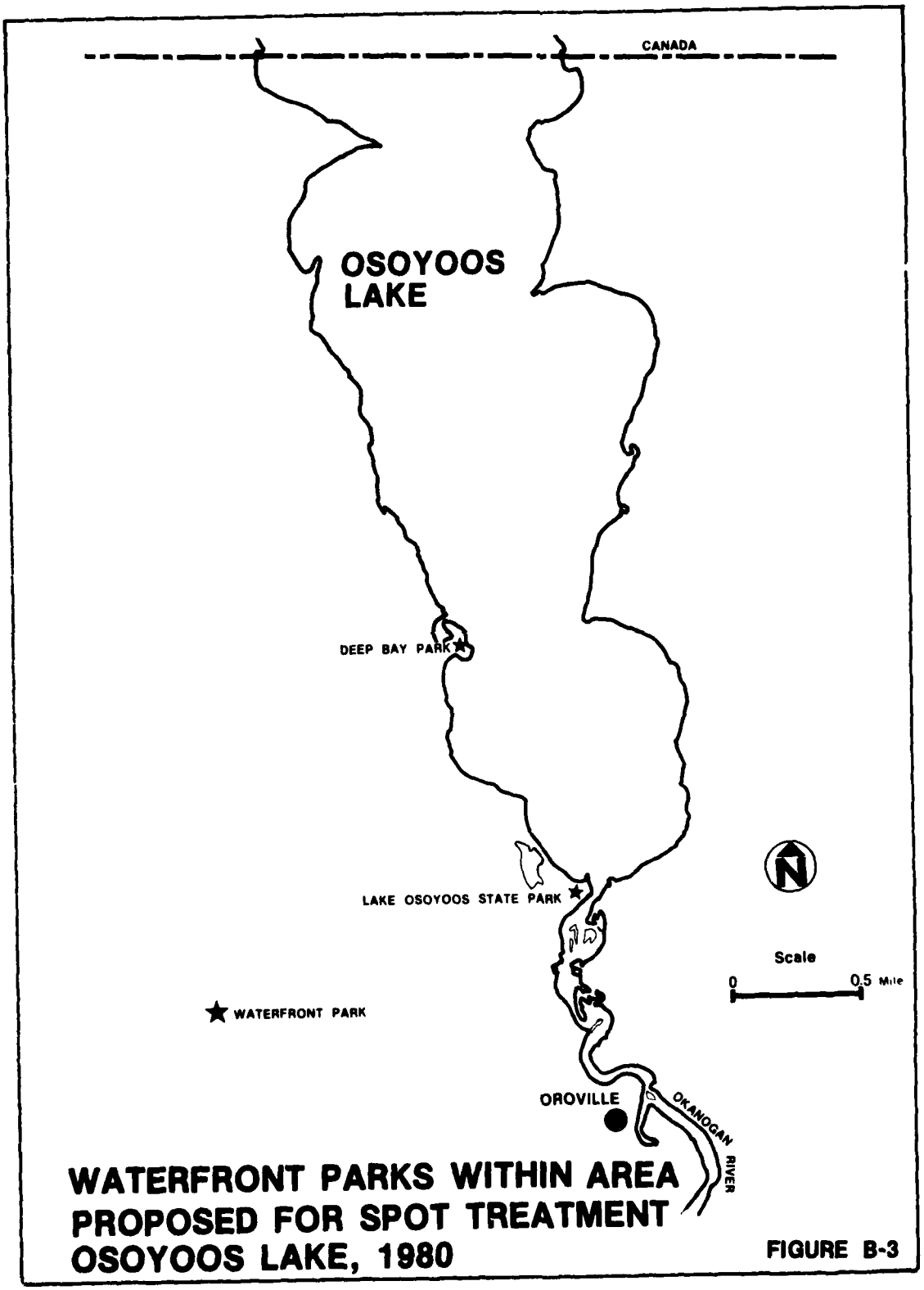
7. To convert recreation loss to economic benefits, a recreation value of $2 per activity was assigned. This value, which falls within the guidelines provided by the Water Resources Council's Principles and Standards for Planning Water and Related Land Resources, dated 10 September 1973, reflects both the quality of the swimming and beach activity opportunities and the degree to which comparable opportunities are available. The quality of recreational opportunities in the proposed treatment areas is high due to the proximity of the water bodies to the Seattle metropolitan area and to other recreational and cultural opportunities. Water quality is also very good, and water temperatures are warmer than in nearby saltwater Puget Sound. While numerous alternatives to the seven waterfront parks included in the proposed 1980 control program are available at other swimming beaches in the system, loss of recreational opportunity at these seven due to milfoil infestation would likely be accompanied by a similar loss at neighboring beaches as well. Boating benefits are derived from the "willingness to pay" concept and are based upon the willingness of waterfront property owners to assume the expense of treating milfoil in the public waters adjacent to their property. The value of the benefits are obtained by the cost of the treatment method that property owners would be willing to pay in the absence of any other program. Benefits are based on the treatment of 90 acres of public waters not adjacent to public parks on Lake Washington. Benefits range from $39,000 to $80,000 depending on whether low-cost (Chemical 2,4-D BEE) methods or high-cost (mechanical harvester) methods are considered. For the purpose of this analysis, the more conservative, lower value of $39,000 was used. In the absence of a low-cost program, it is assumed that property owners would be willing to pay for the high-cost program. These higher benefits were not used. The dollar value of public recreation benefits are as follows:

TABLE B-3
PUBLIC RECREATION BENEFITS
CONTROL PROGRAM

	Recreation Loss		Unit Day Value		Economic Benefits
Swimming	160,154	x	$2	=	$320,300
Beach Activity	132,822	x	$2	=	265,600
Boating					39,000
TOTAL CONTROL BENEFITS					$624,900

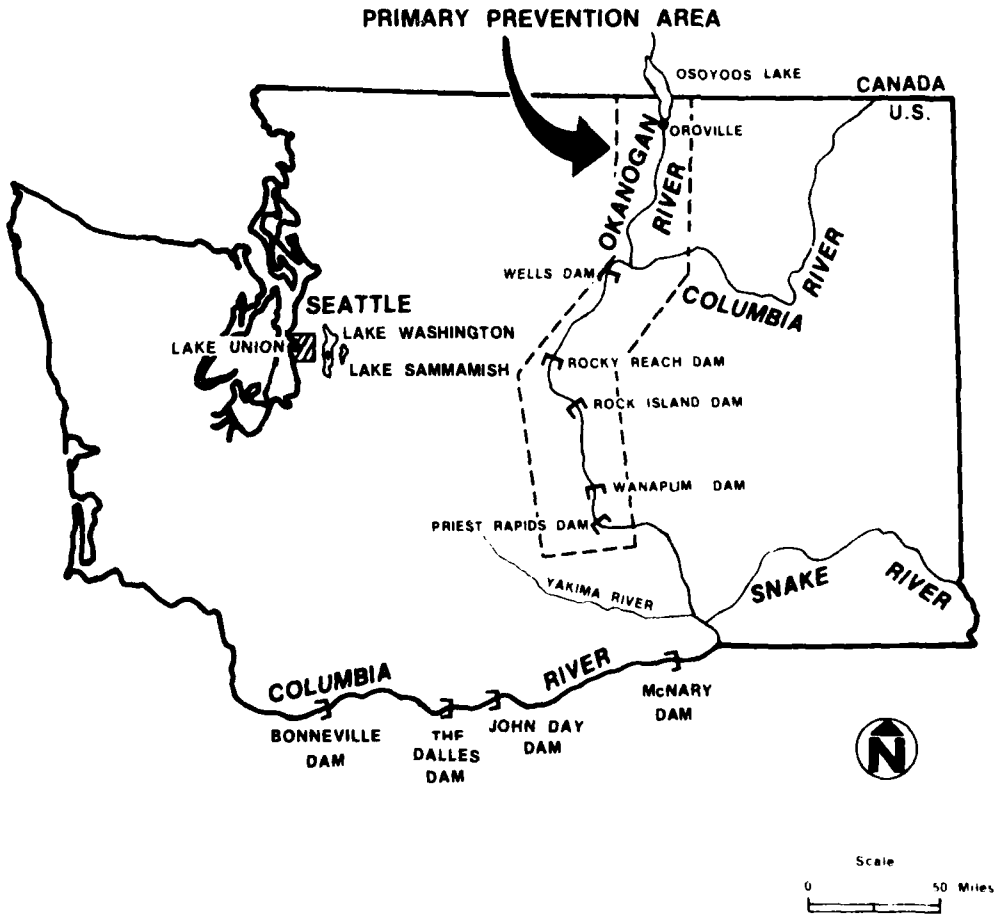
8. Prevention Program. The prevention program for 1980 will encompass the United States portion of Osoyoos Lake (see figure B-3), Okanogan River, and five reaches on the Columbia River: Wells Reach, Rock Reach, Rock Island Reach, Wanapum Reach, and Priest Rapids Reach (see figure B-4).

9. Economic justification for the prevention program is based on the prevention of recreation loss of swimming and beach activity. No



WATERFRONT PARKS WITHIN AREA PROPOSED FOR SPOT TREATMENT OSOYOOS LAKE, 1980

FIGURE B-3



OKANOGAN - COLUMBIA RIVER PRIMARY PREVENTION AREA 1980

FIGURE B-4

recreation benefits are claimed for swimming or beach activity within Rock Island Reach of the Columbia River because no potential for milfoil growth has been identified in this area. Also, no recreation benefits are claimed for swimming or beach activities on the Okanogan River because no public facilities are available on the river.

10. Recreation benefits are claimed for the prevention of recreation loss in the infestable portions of the Columbia River downstream of the prevention program area. This segment of the Columbia River is comprised of the following six river reaches: Hanford Reach, McNary Reach, John Day Reach, The Dalles Reach, Bonneville Reach, and Downstream of Bonneville Reach (see figure B-4). All of these areas, with the exception of the Downstream of Bonneville Reach, are under Federal jurisdiction. Benefits have not been claimed for recreation loss in Hanford Reach, because no potential for milfoil growth has been identified in this area. Total average annual economic benefits over the 100-year period of economic analysis of the prevention program (1980 to 2080) are estimated at $772,000 (see table B-6).

11. Recreation benefits accrue from swimming and beach activity participation which, without a prevention program, would be lost annually because of encroachment of milfoil. Benefits were based on the same assumptions made for the control program in western Washington: (1) losses are claimed only for the three summer months (June, July, and August) during which beaches are officially open for swimming; (2) a 50 percent loss in swimming will occur; and (3) a 35 percent loss in beach activity participation will also occur.

12. The anticipated summer swimming and beach activity for the prevention program area for 1980 is tabulated in table B-4. This forecast represents the recreation expected at the time the prevention program begins. In table B-5, swimming and beach activity is projected to 1993 levels (estimated year of maximum infestation without prevention program) to represent future conditions both with and without the prevention program. The projection of swimming and beach activity to 1993 levels is based on projected rates of increase of swimming activity calculated by the Washington State Interagency Committee for Outdoor Recreation and the Oregon Parks and Recreation Branch, Department of Transportation.

TABLE B-4

PREVENTION PROGRAM AREAS
SUMMER SWIMMING AND BEACH ACTIVITY
BASE CONDITIONS - 1980

Water Body	Recreation Activity	
	Swimming	Beach Activity
Osoyoos Lake[1/]	17,500	21,600
Wells Reach	22,000	27,200
Rocky Reach	27,100	33,500
Wanapum Reach	49,800	61,500
Priest Rapids Reach	32,600	40,300
McNary Reach	68,000	84,000
John Day Reach	25,000	30,900
The Dalles Reach	18,000	22,200
Bonneville Reach	34,000	42,000
Downstream of Bonneville Reach	300,000	370,400
TOTAL PREVENTION PROGRAM AREA	594,000	733,600

1/Includes Osoyoos Lake State Park and Deep Bay Park (Oroville).

SOURCES: Washington State Parks and Recreation Commission, Corps of Engineers' project visitation data, and Corps of Engineers' Columbia River and Tributaries Review Study: Recreation Needs Assessment.

TABLE B-5

PREVENTION PROGRAM AREAS
SUMMER SWIMMING AND BEACH ACTIVITY
FUTURE CONDITIONS - 1993

With Prevention Program	Recreation Activity	
	Swimming	Beach Activity
Total Prevention Program Area	720,400	889,300
Without Prevention Program		
Total Prevention Program Area	360,200	578,045

13. Average annual economic benefits were determined by first calculating average annual equivalent visitation at 7-1/8 percent interest over the 100-year period of analysis (1980 to 2080), both with and without the prevention program. Average annual equivalent visitation was based on swimming and beach activity expected in 1980 (base conditions) and on these activities, with and without the prevention program, projected to 1993. Visitation was assumed to remain constant after 1993. The difference in average annual equivalent visitation, with and without the prevention program, was the value

used to derive economic benefits by applying a recreation unit day value of $1.75 per visitation day lost. This value is based on unit day values assigned to Corps of Engineers' projects upstream and downstream of the prevention program area on the Columbia River, is within Water Resources Council guidelines, and reflects both the quality and availability of swimming and beach activity opportunities. Average annual economic benefits were derived as follows:

TABLE B-6

PUBLIC RECREATION BENEFITS
PREVENTION PROGRAM

	1980-2080 Average Annual Equivalent Visitation		Unit Day Value		Average Annual Economic Benefits 1/ (in $1,000)
Swimming:					
With Prevention Program	680,392				
Without Prevention Program	444,833				
Recreation Loss	235,559	x	$1.75	=	$412,000
Beach Activity:					
With Prevention Program	840,018				
Without Prevention Program	634,354				
Recreation Loss	205,664	x	$1.75	=	$360,000
TOTAL PREVENTION BENEFITS	441,223	x	$1.75	=	$772,000

14. Total Benefits. The total estimated benefits derived from the prevention and control programs are tabulated below:

Prevention Program	$772,000
Control Program	625,000
TOTAL BENEFITS	$1,397,000

1/Based on 7-1/8 percent interest.

appendix c

COORDINATION, SPONSORSHIP LETTERS,
AND PUBLIC INVOLVMENT

APPENDIX C

COORDINATION, SPONSORSHIP LETTERS AND PUBLIC INVOLVEMENT

TABLE OF CONTENTS

EXHIBITS

APPENDIX C

COORDINATION, SPONSORSHIP LETTERS AND PUBLIC INVOLVEMENT

1. Introduction. Public involvement and agency coordination are integral parts of the decisionmaking and plan formulation process, and a variety of coordination methods have been used to maintain contact with Federal, state, local agencies, and the public. These included public meetings, workshops, information pamphlets, brochures, field trips, meetings, and coordination letters. The public involvement program was conducted with representation from Federal, state, and local agencies, as well as the general public, to accomplish the objectives stated in Engineering Regulation 1130-2-412. A description of study coordination and the public involvement program follows.

2. Reconnaissance Report. During preparation of the reconnaissance report for the Aquatic Plant Management Program meetings and coordination with a wide range of Federal, state, local agencies, and groups were conducted. Contact was maintained on the Federal level with the Environmental Protection Agency, U.S. Bureau of Reclamation, Bonneville Power Administration, U.S. Fish and Wildlife Service, Department of Agriculture, the Soil Conservation Service, and the Waterways Experiment Station (WES) of the Corps of Engineers. Washington State agencies involved in the study included the Departments of Ecology, Fisheries, and Game; Parks and Recreation Commission; the University of Washington; and the Pacific Northwest River Basin Commission. Local coordination and contact was maintained with the Municipality of Metropolitan Seattle (METRO), chemical and spray companies, citizen groups, county and city representatives, and concerned citizens. In addition, information was exchanged with the Water Investigations Branch of the Ministry of the Environment in the Province of British Columbia, Canada.

a. Public Workshops. All day public information workshops were held in Seattle and Oroville, Washington, on 12 and 14 July 1977, respectively. There was some premeeting press coverage, and meeting announcements were sent to various agencies, environmental groups, and private citizens. A total of 74 people attended these meetings to discuss their aquatic plant problems and to learn more about aquatic plant control from the Waterways Experiment Station staff.

3. Design Memorandum. A broad range of coordination was maintained with Government agencies, local groups, and the public during preparation of the design memorandum. Coordination efforts included public workshops, a questionnaire, public meetings, a public brochure (exhibit 1), staff meetings, an information pamphlet, and information exchange with other groups and agencies involved in milfoil research.

a. Public Workshops. Two public workshops were conducted by the Seattle District Corps of Engineers and chaired by the Washington State Department of Ecology on 25 and 30 January 1979 in Oroville and Seattle, Washington, respectively. Approximately 50 persons attended the workshops. An information pamphlet about milfoil was mailed along with the letter announcing the times and places of the workshops. Included in the pamphlet was a questionnaire to be filled out and mailed back to the Seattle District by interested individuals. There also were news releases prior to each workshop to inform the public of the meetings. Most of the discussion at the workshops centered on the use of chemicals, particularly 2,4-D, with the majority supporting the use of 2,4-D to control milfoil. After the workshops, formulation studies were initiated to develop alternative treatment methods which could be used in the prevention and control programs.

b. Questionnaire. There were 117 responses to the questionnaire that was mailed with the milfoil information brochure in January 1979. The responses were broken down by geographical locations: 67 percent (78) came from western Washington, 28 percent (33) came from eastern Washington, and 5 percent (6) were from out-of-state. Within western Washington, the 78 (67 percent) responses were further divided into three areas: Lake Washington and vicinity, Lake Sammamish and vicinity, and western Washington; exclusive of the two previously mentioned lake areas. The following table shows the highest percentage response to each question:

	Lake Washington	Lake Sammamish	Western Washington	Eastern Washington
The preferred treatment technique	61% Chemical	59% Chemical	30% Chemical	36% Chemical
Is milfoil perceived as a problem?	88% Yes	100% Yes	70% Yes	79% Yes
Personally encountered problems with aquatic weeds?	88% Yes	100% Yes	61% Yes	61% Yes

With regard to who should be responsible for taking care of aquatic plant problems, the three top choices were: a Federal agency (alone), a state agency (alone), or a combination of agencies (Federal and state, state and county, state and private property owner, etc.).

c. Public Meetings. Two public meetings were conducted by the Seattle District Corps of Engineer on 4 and 6 September 1979 in Seattle and Okanogan, Washington, respectively. The purpose of the public meetings was to discuss the tentative program for management of milfoil in Washington State. Approximately 75 people attended the Seattle public meeting, and 35 people the Okanogan public meeting. There was almost unanimous agreement by all who spoke that milfoil was a problem and that a program was needed to deal with its growth.

Much of the discussion centered on the use of chemicals to control milfoil. At the Seattle meeting, approximately 60 percent favored the use of chemicals and 40 percent stated that more research was needed before any chemicals should be used. Environmental groups (such as the Audubon Society, Sierra Club, and Greenpeace) supported the use of mechanical methods for controlling milfoil. Three medical doctors testified in support of the use of 2,4-D. At the Okanogan meeting the majority of those testifying spoke against the use of any chemicals.

d. Media Involvement. There has been extensive media involvement with the milfoil issue; articles about the program and about milfoil have appeared in numerous newspapers throughout the state. In the Seattle area, several newspapers have covered the milfoil problem, including: The Daily Journal American (Bellevue); The Seattle Times; The Daily (University of Washington); and the Post-Intelligencer (Seattle). In eastern Washington some of the newspapers covering the milfoil issue were: The Gazette Tribune (Oroville); the Tri-City Herald (Pasco); the Herald Republic (Yakima); the Columbia Basin Herald (Moses Lake); and the Wenatchee World. In addition, articles have appeared in Canadian papers, The Vancouver Sun and The Province, both from Vancouver, British Columbia. The radio station KOIN in Portland produced a half-hour program about milfoil, and students from the University of Washington, Department of Communications, have produced a "mini-documentary" on milfoil.

e. Coordination Letters. The Seattle District coordinated the study throughout the State of Washington. Formal coordination letters were sent to the following Federal and state agencies:

Federal

Department of Agriculture - Soil Conservation Service
Department of Commerce - National Marine Fisheries Service
Department of Energy
Department of the Interior - Bureau of Mines
- Heritage Conservation and Recreation Service
- U.S. Fish and Wildlife Service
Advisory Council on Historic Preservation
U.S. Environmental Protection Agency

State of Washington

Department of Fisheries
Department of Game
Office of Archeology and Historic Preservation
Office of Public Archeology - University of Washington
Washington Archeological Research Center - Washington State University
Washington State Historic Society

Other Coordination

Informal coordination (such as meetings and telephone conversations) involving primarily the exchange of information, was maintained with:

State Parks and Recreation Commission
State Department of Agriculture
Bureau of Reclamation
University of Washington
Municipality of Metropolitan Seattle (METRO)
City of Seattle
King County
Tennessee Valley Authority (TVA)
King County Parks Department
City of Seattle Parks Department
Ministry of the Environment, Province of British Columbia

f. Local Coordination. Throughout plan formulation, the coordinating or "umbrella" sponsor, Washington State Department of Ecology, has strongly supported the establishment of a milfoil prevention and control program in Washington State. Support was expressed by the Department of Ecology by letter dated 4 August 1977 (exhibit 2). By letter dated 4 April 1979 (exhibit 3), the Department of Ecology reaffirmed its commitment to act as the statewide "umbrella" sponsor.

g. Fish and Wildlife. Detailed coordination regarding fish and wildlife resources and possible alternative treatment program impacts has been carried out. This coordination aided plan formulation, preparation of the Fish and Wildlife Coordination Act Report (by the U.S Fish and Wildlife Service), and the Environmental Impact Statement.

The following agencies were contacted concerning program impacts to fish and wildlife resources: U.S. Fish and Wildlife Service, National Marine Fisheries Service, Washington State Department of Game and Washington State Department of Fisheries. Their information and recommendations were considered in plan formulation. The Fish and Wildlife Coordination Act Report is attached as appendix D. Their recommendations and Seattle District responses are summarized below.

A. Chemical Control:

Recommendation 1: The Corps of Engineers should condition their funding of local governments to restrict chemical treatment to 2,4-D acid equivalent formulations incased in attaclay particles. Funding should not support the following:

a. Aerial applications of any liquid formulations.

b. Use of diquat, casaron, endothall or any other identified herbicides.

Response: The liquid formulation of 2,4-D (DMA) is less toxic to aquatic organism and would be acceptable for use in some areas; it is therefore still included in the program.

a. No aerial application of any herbicide formulation is recommended.

b. Use of the herbicides diquat, dichlobenil, and endothall (dipotassium salt) is acceptable as a treatment method only for very limited use, for areas in which the exclusion of all aquatic growth is acceptable (e.g., swimming beaches). Diquat, dichlobenil, and endothall cannot be used in irrigation waters. Restrictions on swimming, fishing, and the use of treated water for drinking would be necessary for a period of time after application of these herbicides.

Recommendation 2: Corps of Engineers require post treatment monitoring to determine:

a. The percent and duration of the milfoil control.

b. The effect on nontarget plant species.

c. Fish or invertebrate kills.

Response: A comprehensive program of monitoring and evaluation will be conducted to determine the effectiveness of all treatment measures. Also, the percentage of root kill and the selectivity of the plant kill will be evaluated for the chemical treatment alternatives. The herbicide application rate, persistence, and degree of drift will also be monitored and evaluated Fish or invertebrate kills, should they occur, would be evaluated to determine their causes. Modfications to future herbicide treatment procedures would subsequently be made.

Recommendation 3: Rehabilitation funds be set aside and held for a period of one growing season. Funds would be used to:

a. Rehabilitate nontarget macrophytes if they show no recovery within the first growing season.

b. Compensate for any fish or invertebrate kills that are shown to be a direct result of the treatment program.

Response: The Aquatic Plant Management Program will be reviewed and funded on an annual basis. There is no provision to set aside funds for rehabilitation and compensation purposes. Reallocation of funds for these purposes will be contingent upon evidence that adverse impacts such as those mentioned have resulted from chemical treatment methods or procedures.

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STATE OF WASHINGTON, AQUATIC PLANT MANAGEMENT PROGRAM: DESIGN M--ETC(U)
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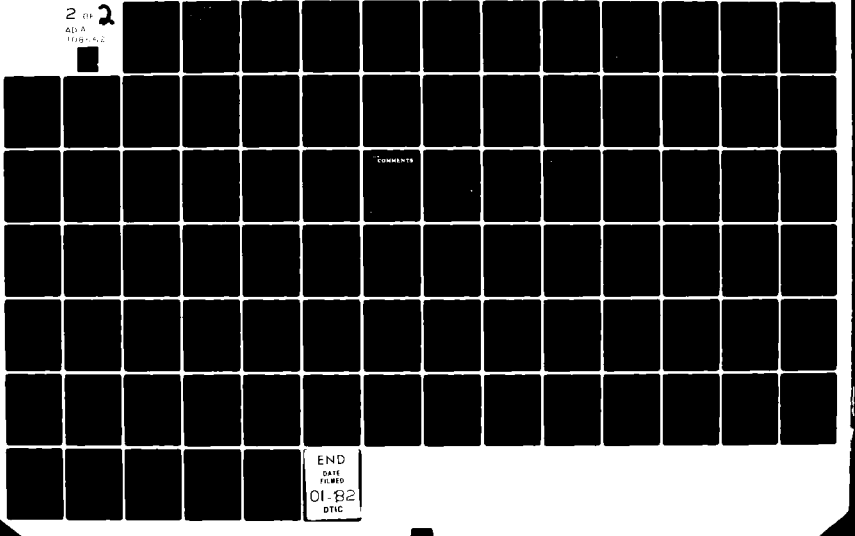

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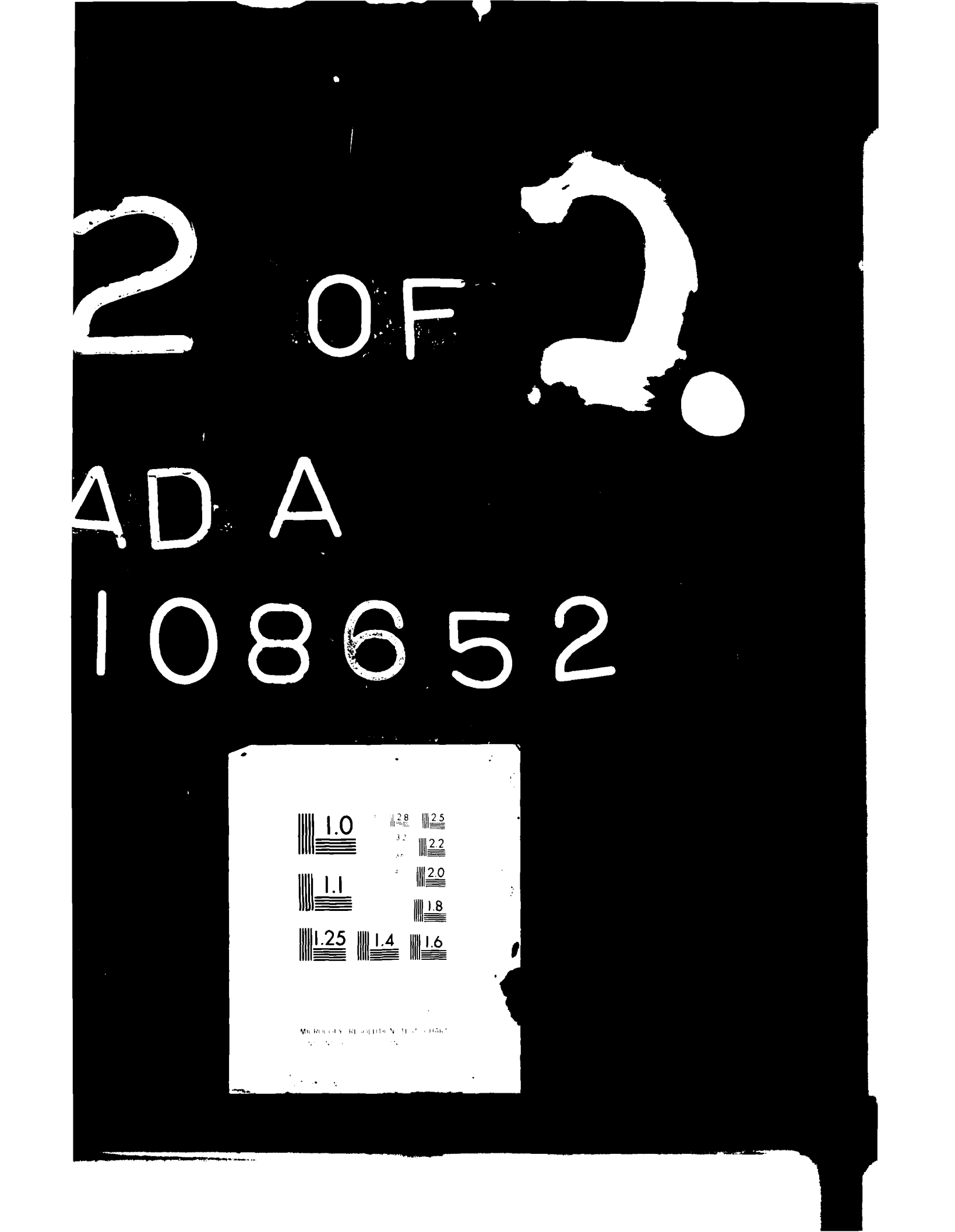
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Recommendation 4: Investigate the feasibility of treating mouths of known anadromous spawning streams to disperse possible predator fish populations and enhance juvenile salmonid migration success. Discussions should include Washington State Departments of Game and Fisheries, National Marine Fisheries Service, Fish and Wildlife Service, and the Corps Environmental Resources Section.

Response: We have no knowledge that milfoil growths are harboring predator fish populations at the mouths of anadromous fish spawning streams. Treatment of these areas is not included in the proposed program. The program will be evaluated annually, however, and additional treatment areas could be designated if a need is identified.

B. Mechanical Control:

Recommendation 1: Mechanical control should be restricted to cutting devices. The use of rototillers, suction dredges, or other devices that disrupt the bottom strata and destroy benthos should not be funded with Federal monies.

Response: Acceptable alternative mechanical treatment methods include rotovating and suction dredge, in addition to mechanical harvesting and hand removal. Generally, rotovators and suction dredges would be used in areas where the complete removal of pioneer colonies is necessary to prevent spread and where the area is too large for hand removal and herbicides cannot be used.

Recommendation 2: Mechanical control not be conducted on a continuing basis in areas with identified nontarget species, benthic invertebrates, or spinyray sport fisheries.

Response: There is significant public support for a mechanical harvesting alternative for milfoil control. We have been unable to identify any adverse impacts significant enough to preclude its use. Mechanical harvesting may, in fact, benefit native vegetation by stressing the milfoil population and eliminating the upper part of the milfoil plants which serve to shade out other species. Accordingly, mechanical harvesting has been included as an alternative in our proposed program.

STATE OF WASHINGTON AQUATIC PLANT MANAGEMENT PROGRAM

PUBLIC BROCHURE AUGUST 1979

Bob Rawson, Study Manager 206-764-3622
Seattle District, U.S. Army Corps of Engineers
P.O. Box C-3755, Seattle, Wa. 98124

EXHIBIT 1

TABLE OF CONTENTS

WHY THIS PROGRAM?

In response to the serious problems caused by certain aquatic plants, Congress enacted Section 302 of the River and Harbor Act of 1965 (Public Law 89-298). This Act authorized the U.S. Army Corps of Engineers to participate with states in a cost-shared program for the control and progressive eradication of obnoxious aquatic plant growths from the navigable waters, tributary streams, connecting channels, and other allied waters of the United States.

In April 1977, the Washington State Department of Ecology and the Municipality of Metropolitan Seattle (METRO) requested Corps of Engineers' assistance in the development of an aquatic plant management program for Washington State. A reconnaissance report, dated August 1977, was prepared by the Corps of Engineers. It identified problem areas and recommended that further planning be undertaken.

WHY THESE MEETINGS?

The Seattle District, Corps of Engineers, is holding public meetings in Seattle at 7:30 p.m. on Tuesday, 4 September 1979, at the Federal Center South Auditorium and in Okanogan at 7:30 p.m. on Thursday, 6 September 1979, at the Okanogan County P.U.D. Auditorium. At these meetings, we will inform the public about the status of the proposed program to control the introduced aquatic plant Eurasian watermilfoil (Myriophyllum spicatum L.), hereafter referred to as watermilfoil, within the State of Washington and provide a means of public input into the program.

WHAT DOES THIS BROCHURE DO?

This brochure updates the planning that has taken place since the public workshops, provides the tentative Corps of Engineers' recommendations for the Aquatic Plant Management Program, presents the framework for implementation of the program, and compares the alternative methods of aquatic plant control and prevention. The brochure provides you, and other interested parties, a means for public comment on the proposed Aquatic Plant Management Program. You may use the sheet in the back of the brochure for your comments. Then cut it out, fold, staple, and mail it back to us. We pay the postage. Your comments are important! Please share them with us. Comments can also be turned in at the public meetings, or you may write or telephone (see cover) the Aquatic Plant Study Manager, Mr. Bob Rawson, with comments or questions.

WHAT HAS HAPPENED SINCE THE PUBLIC WORKSHOPS

Public workshops on the Aquatic Plant Management Program were held on 25 January 1979 in Oroville, and on 30 January 1979 in Seattle. Most of those attending the workshops supported a program to control watermilfoil and prevent its spread. In conjunction with the public workshops, information pamphlets and questionnaires were mailed to a wide range of Federal, state, and local agencies and concerned individuals. There were 121 responses, of which 67 percent came from western Washington, 28 percent from eastern Washington, and 5 percent from out-of-state. Following the workshops, we prepared a summary of the responses to the questionnaires which is shown on the following page.

In addition to the specific responses to these questions, we received other comments and questions. These are listed on pages 25 to 29 along with our answers and responses.

Since the public workshops, we have been continuing our study to arrive at a specific recommendation for a statewide aquatic plant management program. We have evaluated the public input received both at and following the public workshops, and have continued our coordination with the Washington Department of Ecology, METRO, and other Federal, state, and local agencies concerned with aquatic plant management. We have examined various options for control of watermilfoil, and have looked at various alternative areas that could be included in a control and prevention program. In addition, we have prepared a draft environmental impact statement and design memorandum which are currently being reviewed.

WHAT IS THE CORPS TENTATIVE RECOMMENDATION FOR THE AQUATIC PLANT MANAGEMENT PROGRAM?

Our studies have indicated that watermilfoil already is a major nuisance in several lakes and reservoirs in the Columbia Basin and Puget Sound areas and, if left unchecked, could spread to every body of fresh and brackish water. Therefore, we are recommending a plan for aquatic plant management consisting of both control and prevention programs. The program areas are shown on the map on page 5. The control program would have the objective of reducing watermilfoil populations to acceptable levels in navigable waters where there is a substantial impact upon recreational or esthetic resources or upon

QUESTIONNAIRE RESPONSES

QUESTION:

Do you favor one technique for the control of Eurasian watermilfoil over the others?

RESPONSE:

Chemical	Mechanical	Environmental Manipulation	Biological	Integrated Control	Other	No Preference	No Comment
46%	8%	3%	2%	8%	5%	17%	11%

QUESTION:

From your own observation or experience, do you think there is a problem or potential problem posed by the invasion of Eurasian watermilfoil into Washington State waters?

RESPONSE:

Yes	No	No Comment	Other
81%	1%	16%	2%

QUESTION:

Have you personally experienced a problem with the growth of aquatic plants in the waters of Washington State?

RESPONSE:

Yes	No	No Comment
71%	17%	12%

QUESTION:

If you were to have a problem with aquatic plants, whom do you feel should be responsible for taking care of the problem?

RESPONSE:

Federal Government	State Government	County Government	METRO	Property Owners	Joint Effort	Other	No Comment
21%	15%	2%	5%	15%	25%	5%	13%

navigation, irrigation, hydropower, and public access within the constraints of environmental concerns and economic justification. Total eradication of firmly established watermilfoil populations would not be attempted, since such efforts have not been successful elsewhere. The prevention program would have the objective of halting the spread of watermilfoil from currently infested water bodies into uninfested navigable waters. Eradication of new watermilfoil colonies would be attempted, since eradication prior to firm establishment of populations in new areas is both feasible and cost-effective.

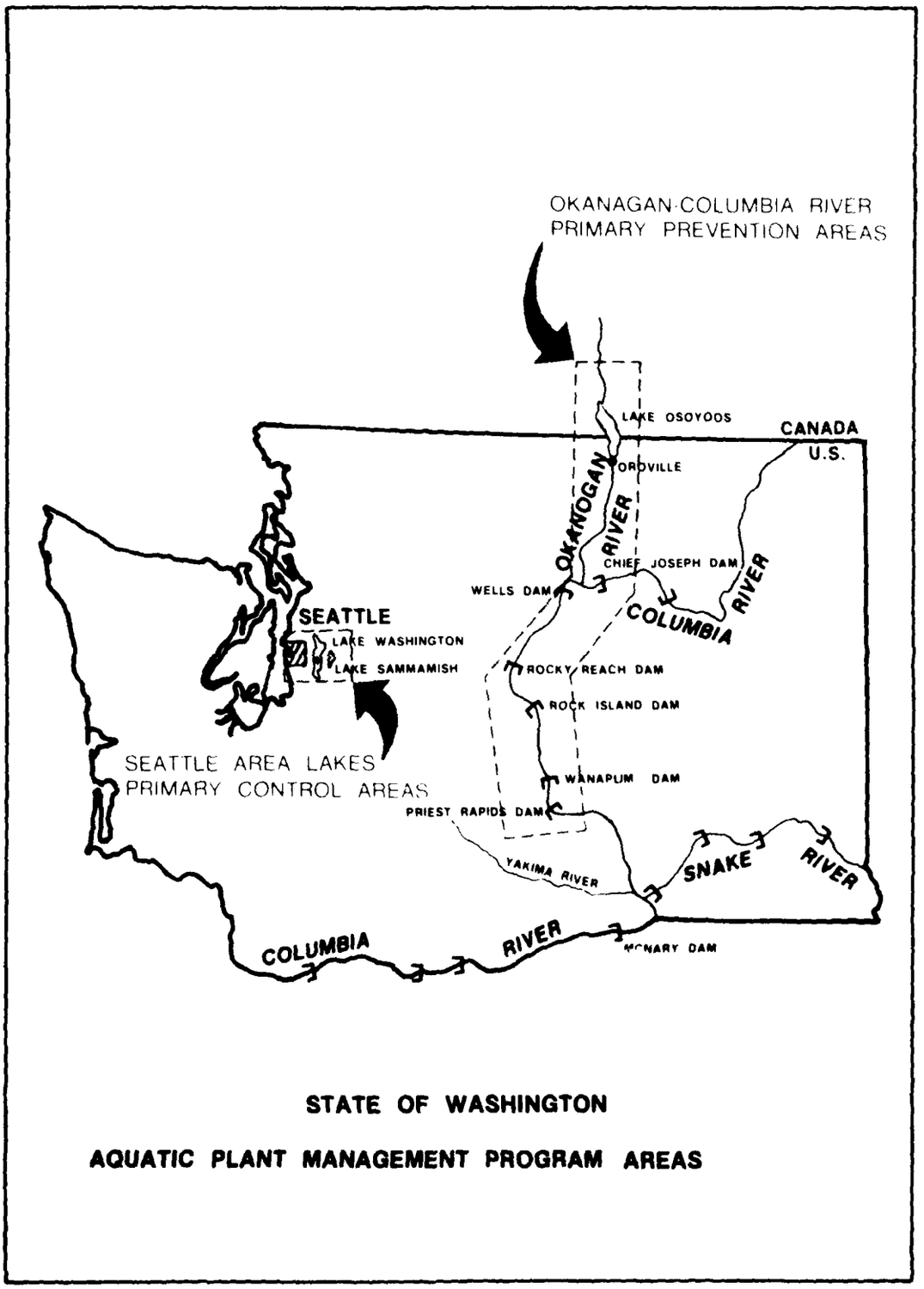
THE CONTROL PROGRAM

The proposed 1980 control program would involve treatment of the most critical problems caused by watermilfoil populations in Lakes Washington, Union, and Sammamish, all in the Seattle area. A total of approximately 90 acres which experience heavy recreation use would be treated. There are 10 treatment locations on Lake Washington, one on Lake Union, and one on Lake Sammamish. The proposed treatment areas are shown on the maps on pages 6 and 9, and described in the following paragraphs.

LAKE WASHINGTON

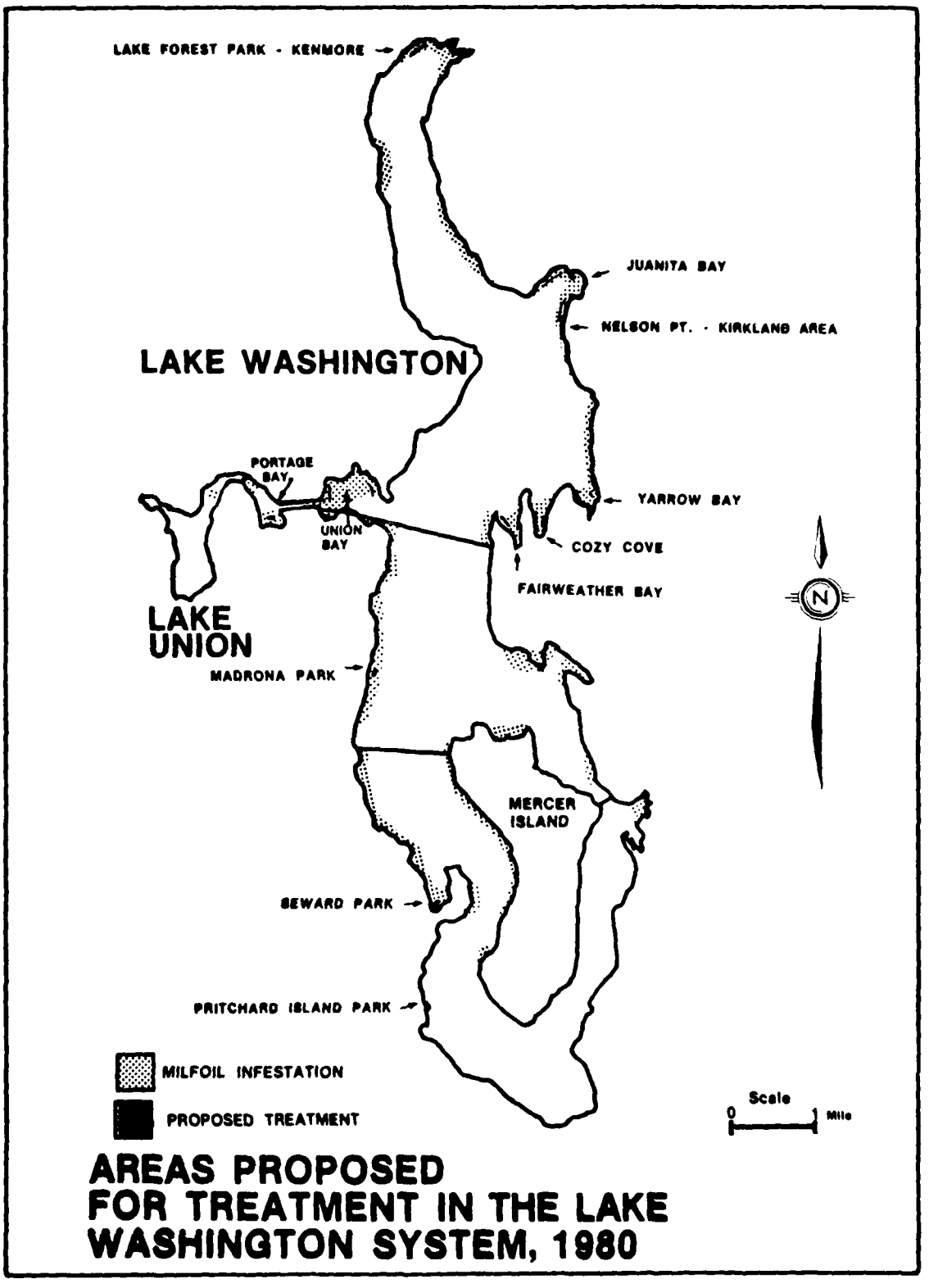
Union Bay - Union Bay has approximately 350 surface acres, of which about 200 are heavily infested with watermilfoil. The proposal for Union Bay is to treat a 100-foot-wide channel in the high-use area along the shoreline of Webster Point, a distance of about 1,000 yards. In addition, a 100-foot-wide channel in front of the University of Washington Yacht Club basin and boathouse and a 100-foot-wide channel on the south Union Bay shoreline fronting an apartment area are proposed. The total treatment area is about 17 acres. The recommended treatment methods for Union Bay are mechanical harvesting or the application of 2,4-dichlorophenoxyacetic acid (2,4-D).

Lake Forest Park - Kenmore - This area contains approximately 250 acres, of which 100 are infested with watermilfoil. The proposal for this area is to treat a 100-foot-wide channel along the shoreline for approximately 800 yards in the vicinity of the King County Logboom Park and south to the Lake Forest Park Community Beach. Additional treatment would be performed, as required, along the county park frontage to maintain full public use. The total treatment area would be approximately 9 acres. The recommended treatment methods are mechanical harvesting or the application of 2,4-D. In addition, use could be made of Endothall, Casoron, Diquat, or bottom shading.



STATE OF WASHINGTON

AQUATIC PLANT MANAGEMENT PROGRAM AREAS



AREAS PROPOSED FOR TREATMENT IN THE LAKE WASHINGTON SYSTEM, 1980

Juanita Bay - This bay has a surface area of approximately 185 acres; and about 50 acres are heavily infested with watermilfoil, including areas of the Juanita Beach County Park. The proposal for this area is to treat a 100-foot-wide channel along the shoreline where high usage corresponds with heavy watermilfoil infestation, and to treat the water area of the county park. The total treatment area for Juanita Bay would be approximately 7 acres. The recommended treatment methods are mechanical harvesting or the application of 2,4-D. In addition, the county park could make use of Endothall, Casoron, Diquat, or bottom shading.

Nelson Point - Kirkland Area - This area has been heavily infested by watermilfoil; it is obstructing swimming and boating. The proposal is to treat a 100-foot-wide channel along 1,700 yards of the shoreline. The total treatment area would be approximately 12 acres. The recommended methods of treatment for this area are mechanical harvesting or the application of 2,4-D.

Yarrow Bay - Yarrow Bay has an area of about 118 acres, of which about 25 acres are heavily infested with watermilfoil. The proposal is to treat a 100-foot-wide channel along the shoreline where heavy recreation use occurs. It would include about 900 yards of shoreline, a total of about 6 acres. The recommended treatment methods in this area are mechanical harvesting or the application of 2,4-D.

Cozy Cove - About 40 acres in the cove have been infested with watermilfoil that has obstructed boating and swimming. The proposal for Cozy Cove is to treat a 100-foot-wide channel along the shoreline for approximately 1,400 yards. The total treatment for Cozy Cove would be approximately 10 acres. The recommended methods of treatment are mechanical harvesting or the application of 2,4-D.

Fairweather Bay - Fairweather Bay has an area of about 87 acres, of which 40 acres are infested with watermilfoil that is obstructing boating and swimming activities. The proposal for the bay is to treat a 100-foot-wide channel along two sections of shoreline totaling approximately 2,500 yards. The total treatment for Fairweather Bay would be approximately 17 acres. The recommended methods of treatment are mechanical harvesting or the application of 2,4-D.

Seward, Madrona, and Pritchard Parks - These are Seattle city parks, located on the west side of Lake Washington, which are being obstructed by watermilfoil growth. The proposal for these parks is to treat the swimming areas to a degree that will adequately maintain public recreation. The total area to be treated in these three parks is approximately 2 acres. The recommended treatment methods are mechanical harvesting, application of 2,4-D, Endothall, Casoron, Diquat, or bottom shading.

LAKE UNION

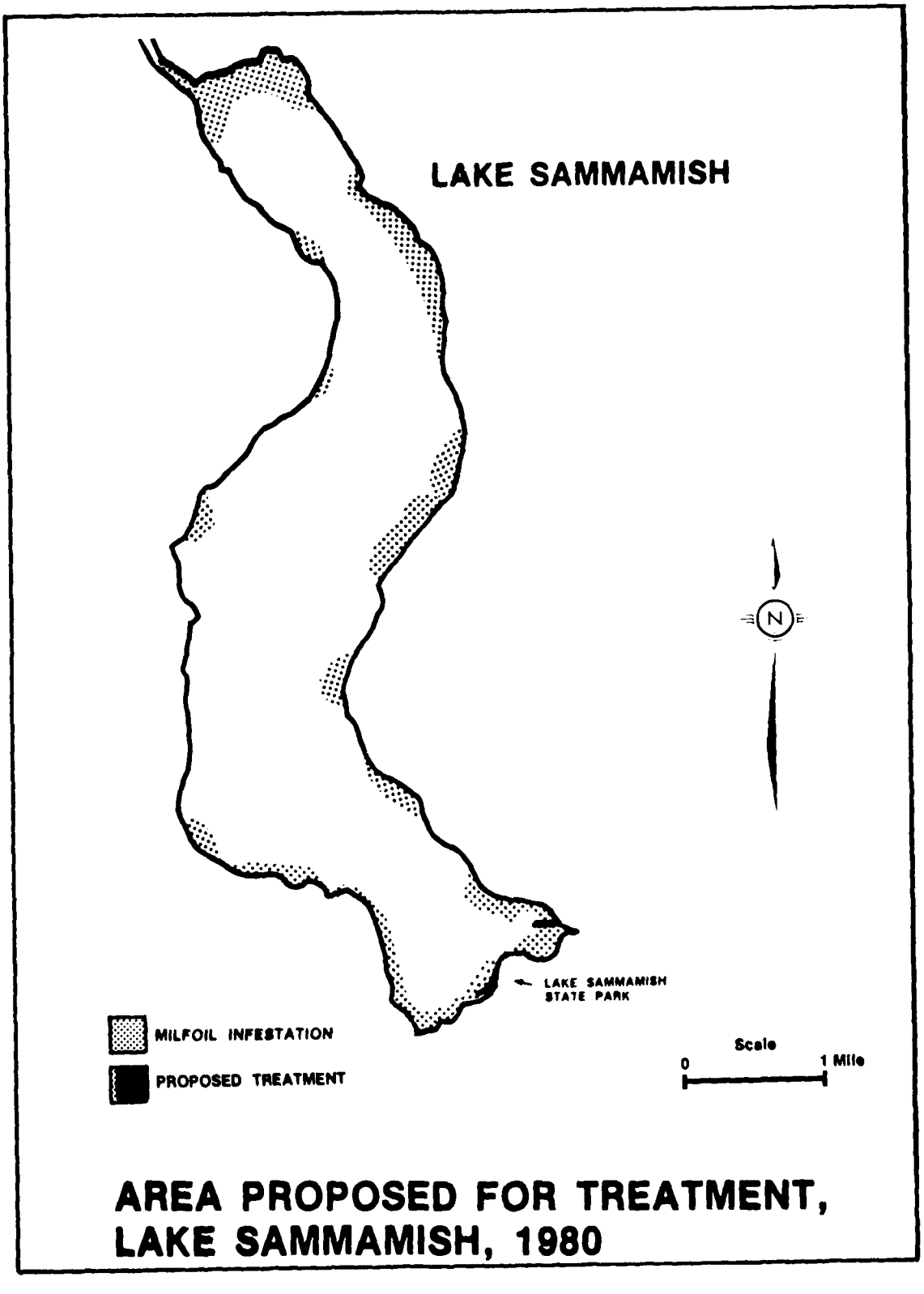
Portage Bay - About 10 acres in Portage Bay have been infested with watermilfoil. The proposal for Portage Bay is to treat the watermilfoil which is blocking access to the navigation channel from the southern end. The treatment area would be approximately 4 acres. The recommended methods of treatment are mechanical harvesting or the application of 2,4-D.

LAKE SAMMAMISH

Lake Sammamish State Park - The only area proposed for initial treatment in Lake Sammamish is the Lake Sammamish State Park. This is a high-use public recreation area which is being obstructed by watermilfoil. The proposal for the park is to treat the swimming area to a degree that will adequately maintain public recreation, and to provide for access from the boat ramp to open water. The total treatment area would be less than 2 acres. The recommended treatment methods are mechanical harvesting, application of 2,4-D, Endothall, Casoron, Diquat, or bottom shading.

BENEFITS AND COSTS

Economic benefits for the 1980 control program are estimated at $930,000. For the public areas, benefits are based on prevention of the loss of recreation opportunities (swimming and beach activities) that would occur in the absence of a treatment program. For the nonpublic areas to be treated, benefits would consist of the prevention of loss of swimming, boating, and water-skiing opportunities, preservation of public health and safety, and preservation of esthetic values. These benefits to nonpublic areas are not easily quantified. Therefore, their value has been based on the cost of the most likely, least-cost alternative that landowners would invest in, in the absence of a Federal program, that would provide the same level of control. The 1980 cost of the control program, including administration and supervision, is estimated to range from about $33,000 to $170,000, depending on the treatment method. The benefit-to-cost ratio would range from 5.0 to 1 to 28.0 to 1 for the program.



AREA PROPOSED FOR TREATMENT, LAKE SAMMAMISH, 1980

THE PREVENTION PROGRAM

The proposed 1980 prevention program would be concentrated on Lake Osoyoos, the Okanogan River, and the Columbia River reservoirs. The program for each of these areas is discussed in more detail in the following paragraphs.

LAKE OSOYOOS

Lake Osoyoos - The northern half of Lake Osoyoos lies in Canada, and has significant colonies of watermilfoil which are a constant source of fragments for the southern (United States) half. The southern half of Lake Osoyoos has a few small "pioneer" colonies and scattered plants, and is a source of fragments for the Okanogan River. The proposal for Lake Osoyoos is to immediately treat all patches of watermilfoil identified by aerial or ground surveillance. The purpose of this treatment will be complete elimination of known colonies. The proposed methods of treatment on Lake Osoyoos would be the application of 2,4-D, use of a suction dredge, rotovating, or hand pulling, depending on colony size and onsite conditions.

OKANOGAN RIVER

The Okanogan River drains Lake Osoyoos and is, therefore, subject to fragmented watermilfoil floating downstream. Small colonies of watermilfoil have been reported in the upper river channel. The proposal for the Okanogan River is to operate and maintain the recently constructed barrier downstream of known colonies in order to slow the spread of fragments and to treat colonies in the river channel, identified by aerial and ground surveillance, in order to eliminate the sources of fragments. The proposed methods of treatment in the river channel would be the application of 2,4-D, use of the suction dredge, rotovating, or hand pulling, depending on the colony size and onsite conditions.

COLUMBIA RIVER RESERVOIR

There are five Columbia River reservoirs which lie downstream from the mouth of the Okanogan River and are also adjacent to the Columbia Basin Irrigation Project which has several existing sources of watermilfoil fragments. These reservoirs are Wells, Rocky Reach, Rock Island, Wanapum, and Priest Rapids. All except Rock Island will be

included in a surveillance program which includes possible spot treatment. Rock Island has been excluded because there has been no potentially infestable area identified in the reservoir. The proposal for the reservoir areas is to maintain aerial and ground surveillance to detect any new or existing watermilfoil colonies, and to eradicate them before they become thoroughly established. The proposed treatment methods would be the application of 2,4-D, the suction dredge, rotovating, or hand pulling, depending on the size of the colony and environmental conditions at the site.

BENEFITS AND COSTS

Economic justification for the prevention portion of the program is based on prevention of recreation loss (swimming and beach activity) for the prevention program areas. The average annual economic benefits are estimated at $334,000. The estimated cost is $200,000, for a benefit-to-cost ratio of 1.7 to 1.

DESCRIPTION OF TREATMENT METHODS

In evaluating which method should be included in the Aquatic Plant Management Program, a number of different factors were considered, including environmental effects, performance, cost, and regulatory requirements. The treatment methods which have been selected for the Aquatic Plant Management Program are mechanical harvesting; rotovating; suction dredge; hand removal; chemical control with 2,4-D, Endothall, Casoron, Diquat; and bottom shading. The paragraphs which follow present a brief description of each method, including its advantages, disadvantages, and cost. A table comparing some of the effects of the selected methods is presented on pages 12 and 13.

Mechanical Harvesting. Mechanical harvesting would entail cutting aquatic vegetation 5 to 8 feet below the water surface and removing the cut vegetation from the water. The root systems are not affected, so the plants would continue to grow. There are several different types of harvesters available, from large units which automatically pick up the cut plants to small cutter boats which require hand pickup. Because watermilfoil is spread by fragmentation, harvesting can speed its dispersal. Containment booms are often used around the treatment areas to minimize floating fragments, but they are not 100-percent effective. For these reasons, mechanical harvesting should be limited to areas which do not require complete control and do not directly threaten uninfested waters. One of the main problems with harvesting watermilfoil is upland disposal. Transport and handling are expensive, and many attempts have been made to find a use for the harvested watermilfoil to partially defray

COMPARISON OF EFFECTS OF TREATMENT METHODS

TREATMENT METHOD	IMPACTS					
	AIR QUALITY, NOISE AND TRAFFIC	ESTHETICS	WATER QUALITY	VEGETATION	FISH	PUBLIC HEALTH
Mechanical Harvesting	Minor adverse impacts due to exhaust emissions from harvester and haul trucks, increased noise from harvester and haul trucks and increased traffic from haul trucks. Impacts minor and of short duration.	Beneficial impacts due to the removal of watermilfoil mats from surface and reduction of volume of milfoil washed ashore in fall. Short-term negative impact of harvesting equipment on water.	Beneficial impacts because it slows eutrophication and reduces biological oxygen demand associated with plant decay. No significant adverse effects.	Harvester is non-selective so all plants present are cut above substrate. Possible beneficial impact on species diversity. Root structure remains so plants continue to grow.	Some fish lost during harvesting. May benefit game fish by increasing edge effect. Loss of habitat for organisms lower in food chain could adversely impact fish if a large area is treated.	Reduction of mosquito breeding areas and mosquito population.
Rotovating	Basically the same as mechanical harvesting.	Same as mechanical harvesting, except for the additional short-term adverse impact of increased turbidity.	Same beneficial impacts as mechanical harvesting. Serious short-term adverse impacts due to turbidity and resulting disruption to benthic organisms. Possible stimulated algal growth and adverse impacts of pollutants previously bound in sediment.	Rotovating is non-selective. Entire plants are removed including nontarget species.	Same impacts as mechanical harvesting but over longer period.	Same as mechanical harvesting.
Suction Dredge	Minor adverse impacts on air quality and noise due to outboard motor on power dredge and compressor for suction hoses. No adverse impacts on traffic. Impacts minor and of short duration.	Same impacts as mechanical harvesting.	Same impacts as rotovating.	Suction dredge could be selective in removing only watermilfoil. Nontarget species benefited.	No effect except loss in food organisms if treatment area large.	Same as mechanical harvesting.
Hand Removal	No impacts.	Same beneficial impacts as mechanical harvesting. No adverse impacts.	Same beneficial impacts as mechanical harvesting. A minor increase in turbidity.	Hand removal could be selective in removing only watermilfoil. Nontarget species benefited.	No effect except for a loss in food organisms if treatment area is large.	Same as mechanical harvesting.

COMPARISON OF EFFECTS OF TREATMENT METHODS (con.)

TREATMENT METHOD	IMPACTS					
	AIR QUALITY, NOISE AND TRAFFIC	ESTHETICS	WATER QUALITY	VEGETATION	FISH	PUBLIC HEALTH
2,4-D	Minor adverse impact due to exhaust emissions and noise from applicator boat. No impact on traffic. Impacts minor and of short duration.	Same beneficial impacts as mechanical harvesting. No adverse impacts.	Possible adverse impacts due to rapid die off and decomposition creating short-term biological oxygen demand and longer-term buildup of organic sediment. Possible rapid growth of algae or other aquatic plants due to release of nutrients.	2,4-D is selective to watermilfoil. Water stargrass also killed. Nontarget species benefited. Roots of watermilfoil killed.	Toxicity of 2,4-D to fish dependent upon chemical formulation and species of fish. No fish kills expected at concentrations used to control milfoil. Possible fish kills in shallow lakes and embankments due to lowered dissolved oxygen. Loss of food organisms if treatment area is large.	Toxic to humans at high concentrations. Possible chronic health effects from exposure to high concentrations. No indication of health problems in concentrations used for aquatic plant control.
Endothall, Casoron, or Diquat	Same as 2,4-D.	Same as 2,4-D.	Same as 2,4-D.	Nonselective herbicides which would kill both target and nontarget species.	Basically similar to 2,4-D.	Toxic to humans at high concentrations. No indication of health problems at concentrations used for aquatic plant control.
Bottom Shading	No impacts except minor effects if small boat needed for installation.	Same beneficial impacts as mechanical harvesting. Some minor increased turbidity.	Some adverse impacts of biological oxygen demand and release of nutrients as chemical control.	Would block sunlight to all aquatic plants, both target and nontarget. No regrowth.	No direct impact but loss of shelter and food organisms' habitat.	Same as mechanical harvesting.

the cost. None have been too successful. The cost per acre for mechanical harvesting would generally range from $900 to $1,100 (two treatments per year). Cost would be dependent on many variables, including location, water depth, and method of disposal.

Rotovating. Rotovating involves "tilling" the sediment to a depth of 6 inches to dislodge plant roots. The plant parts float to the surface and are then removed. The treatment area is surrounded by containment booms to prevent the spread of fragments. The method is not 100-percent effective because all of the plants do not float, nor are they always all removed. Because of the environmental disruption caused by rotovating, it should be used only when complete removal of the plant is required, when the treatment area is too large for either hand pulling or a suction dredge, and when herbicide application is not possible. The cost per acre for rotovating would generally range from $600 to $700, not including disposal costs.

Suction Dredge. The suction dredge involves the use of a small barge or boat equipped with compressors and suction hoses. The suction hoses are small and are controlled by divers, who use them to remove individual watermilfoil plants, roots and all. The plant parts are carried through the hoses to a holding basket on the barge which separates the plants from the water and sediment. The water is discharged, along with the sediment, to the water body. Because of the high cost and the limited amount of area which can be treated, the suction dredge is feasible only for small areas which require complete watermilfoil removal, are too large for hand pulling, and cannot be treated with an herbicide. The cost per acre for a suction dredge would generally range from $800 to $900, not including costs of disposal.

Hand Removal. Hand removal can consist of either pulling individual plants by hand which removes the roots, or by using a rake or other tool which would remove only the foliage. This method is obviously very limited, but can be used to clear around private piers or to remove very small patches to prevent spread. Cost per acre was not calculated.

2,4-D. The chemical 2,4-D is a systemic herbicide which would kill the milfoil roots as well as the upper plant portion. 2,4-D has a high degree of selectivity for watermilfoil, and would not affect most native species at concentrations recommended for treatment. It is suitable for use in most of the state waters currently infested with watermilfoil. It would be especially useful in areas that are too large for hand removal or suction dredge and where complete control is required. 2,4-D would have use restrictions in the vicinity of domestic or irrigation water intakes, and in areas where salmon spawn or are reared. The cost per acre would be dependent on such

variables as the form of the chemical (liquid or granular), size of the area to be treated, water depth, and site location. The cost would generally range between $300 and $400 per acre.

Endothall, Casoron, Diquat. Endothall and Diquat are contact herbicides; they kill the leaves and stems but do not affect aquatic plant roots. Casoron is systemic and thus would cause some root kill. These chemicals are not selective to watermilfoil; they would also kill many native species of aquatic plants. For this reason, they are recommended for very limited use, primarily for areas in which the exclusion of all aquatic growth is acceptable (e.g., swimming beaches). These chemicals would kill many terrestrial species, so care must be taken to insure that irrigation water is not treated. There are also some restrictions on swimming, fishing, and drinking treated water for a period of time after the treatment. The cost per acre would depend on the chemical used, size of the area to be treated, water depth, and site location. The cost would generally range between $350 and $750 per acre.

Bottom Shading. Bottom shading would involve the installation and anchoring of a polyvinylchloride-coated fiberglass screen (Aquascreen). The screen limits sunlight penetration and effectively eliminates all aquatic growth in the affected area. Because of the cost of the screen and the fact that it eliminates all growth, its use would be justified only for high-use areas where the exclusion of all aquatic growth is acceptable (e.g., swimming beaches). Initial estimates indicate an $8,000-to-$10,000-per-acre treatment cost.

HOW WILL THE AQUATIC PLANT MANAGEMENT PROGRAM BE FUNDED AND IMPLEMENTED?

Under the local cooperation requirements of the Aquatic Plant Management Program, a non-Federal sponsor must agree to the following:

- To hold and save the United States free from claims that may occur from control operations.

- To provide 30 percent of the cost of such operations.

- Provide without cost to the United States all lands, easements, and rights-of-way necessary for the program, including necessary disposal areas.

- Obtain all necessary permits and comply with Federal requirements under Section 10 of the River and Harbor Act of 1899, and Section 404 of the Clean Water Act of 1977 (Public Law 95-217).

- Operate and maintain all containment works, and conduct the program in accordance with regulations prescribed by the Secretary of the Army.

The Washington State Department of Ecology (WDE) has agreed to act as the "umbrella" sponsor for the Aquatic Plant Management Program and would be responsible for implementation of the program with assistance and supervision by the Seattle District of the Corps of Engineers. The program would be administered in accordance with the terms of a contract between WDE and the Seattle District. This does not mean that WDE would provide all the necessary 30-percent non-Federal funding for the program. WDE would work with and through local government agencies which would be expected to perform or contribute to the performance of control and prevention operations within the areas under their jurisdiction. The program would be an ongoing effort, with local agencies submitting treatment proposals to WDE for inclusion in a state program. WDE would consolidate these proposals into an annual state program which would be submitted to the Corps of Engineers for approval. Funding for the 70-percent Federal share of the cost would be provided by the Corps of Engineers.

WHAT OTHER METHODS OF CONTROL WERE CONSIDERED AND WHY WERE THEY NOT INCLUDED IN THE PROGRAM?

There are a number of additional control methods used, or being considered for possible use, in other parts of the United States and Canada which were evaluated for inclusion in the Washington State program. A brief description of each of these methods is presented on the following page, along with the reason they were not selected for inclusion in the Washington State program.

Method and Description	Reason Not Selected
Dredging - A "Mud Cat" hydraulic dredge has been used in British Columbia for watermilfoil control. Sediment and plant roots are loosened by a rotating auger and transferred to a diked disposal area by suction pumps. Treatment cost was approximately $2,000 per acre in 1975.	Removal of such large quantities of sediment has adverse environmental impacts. Treatment costs are high, and obtaining disposal sites would be difficult.
Hydraulic Washing - This method has been tested in British Columbia. High-pressure water jets are used to dislodge plant roots from the sediment. Weeds are collected when they float to the surface. Treatment cost is about $120 per acre.	Method is not successful in removing well-established root systems. It could also cause turbidity and disruption of other aquatic life.
Simazine - Simazine is an aquatic herbicide which would kill watermilfoil and many other aquatic plants, including pondweeds and naiads. It is also toxic to a wide range of land plants.	Simazine is not well suited to the Aquatic Plant Management Program because treatment of the entire water body is required. It cannot be used for spot treatment.
Silvex - Silvex would kill watermilfoil, fanwort, bladderwort, and other water plants. It would also damage a variety of land plants.	Silvex is not recommended since it would have no advantage over 2,4-D, and it has several drawbacks, including higher cost, longer persistence, and higher toxicity. Silvex has been banned by the Environmental Protection Agency.
Fenac - Fenac has been approved for use as an aquatic herbicide in Washington State. It will kill watermilfoil plus several species of pondweed, elodea, southern naiads, waterstargrass, coontail, and slender spikerush. It will also kill a variety of land plants, including agricultural crops.	Fenac is not well suited for use against watermilfoil in proposed treatment areas because treatment must take place after the water body has been drained or drawn down.

Endothall Acid (dimethylamine salt) - Dimethylamine salt of Endothall is approved for aquatic use in Washington State. It will kill a wide range of aquatic plants. It is also damaging to land plants, including agricultural crops.	Endothall is not recommended because it is toxic to fish at lower concentrations than are required to kill watermilfoil.
Water-Level Fluctuation - Dewatering of watermilfoil for 3 weeks gives complete control if there is adequate drainage. Shorter periods of dewatering result in significant reduction of watermilfoil population.	Water-level fluctuation is not feasible, since area being recommended for treatment does not have drawdown capabilities.
Sand or Gravel Blankets - This method has been used in Wisconsin. It is immediately effective but, eventually, silt builds up and aquatic plants reestablish themselves.	Sand or gravel blankets would eliminate all aquatic plants and destroy the bottom-dwelling plants and animals. Less disruptive methods of control are available.
Bottom Barriers - Two types of bottom barriers have been tested in British Columbia: A 4-6-mil polyethylene and a 30-mil "Hypalon." The barriers are installed and anchored to the bottom in the spring, and prevent sunlight from reaching the aquatic plants. They are almost 100-percent effective in eliminating aquatic plants. Costs are $4,000 per acre for polyethylene and $16,000 per acre for "Hypalon."	These barriers have high cost, time-consuming installation, are subject to storm and wave damage, lift because of gas bubbles, and are subject to silt accumulation.
Biological Controls - Research is being conducted for several biological control agents. The White Amur (Asian grass carp) shows promise as a control agent. It consumes large amounts of vegetation. In addition, research projects in Yugoslavia and Pakistan have identified 25 insects feeding on watermilfoil.	Biological control agents must be completely tested before they would be available for watermilfoil control. The White Amur must be evaluated for effects on game fish, aquatic animals, aquatic microorganisms, and native aquatic plants. Biological controls have potential for future use but, presently, no thoroughly tested control agent is available.

WHAT WILL HAPPEN NEXT?

We are currently completing a design memorandum which will describe, in detail, the proposed Aquatic Plant Management Program. The draft environmental impact statement on the program has been circulated for public review. After the public meeting, we will evaluate the public input, modify the recommended control and prevention programs as appropriate, and complete our design memorandum and final environmental impact statement. Our final report is currently scheduled for submission to our higher authority by October 1979.

WHAT CAN I DO?

Part of the reason for preparing this brochure is to provide you a means to comment on the Aquatic Plant Management Program, and to suggest changes or modifications to the tentatively recommended control and prevention programs. Your comments can be written on page 30, which can be cut out and mailed to us. If you need more space, attach additional sheets of paper, making sure, as you staple them together, that our address appears on the outside.

We are inviting you to present comments or information that could have a bearing on our final recommendation. Your input is essential, so that our evaluation can be complete. If you wish to discuss the study at any time, you may write or telephone the study manager at the address and number noted on the cover of this brochure. In order that your comments can be considered before we submit our report and final environmental impact statement, we must receive them by 14 September 1979. Thank you.

AGENCIES AND GROUPS PARTICIPATING IN THE STUDY

	Responded to January 1979 Questionnaire	Participated in January 1979 Public Workshop	Other Participation
LOCAL			
Enumclaw	X		
Granges	X		
Kelso	X		
King County			X
Mercer Island	X		
METRO		X	X
Okanogan	X		
Okanogan County	X	X	X
Oroville	X	X	
Oroville-Tonasket Irrigation District	X		
Port of Clarkston	X		
Port of Whitman County	X		
Renton			X
Seattle			X
STATE			
Department of Agriculture			X
Department of Ecology		X	X
Department of Fisheries			X
Department of Game			X
Department of Natural Resources	X		
Ministry of the Environment, Water Investigations Branch, British Columbia		X	X
Office of Archaeology and Historic Preservation			X
Parks and Recreation Commission	X	X	X
University of Washington			X
Washington State University Cooperative Extension Service	X		
Western Washington University, Department of Geography and Regional Planning	X		

	Responded to January 1979 Questionnaire	Participated in January 1979 Public Workshop	Other Participation
FEDERAL			
Bonneville Power Administration			X
Department of Agriculture			
Forest Service		X	X
Soil Conservation Service			X
Department of Commerce			
National Marine Fisheries Service		X	X
Department of Interior			
Bureau of Land Management	X		
Bureau of Mines			X
Bureau of Reclamation		X	X
Fish and Wildlife Service	X		X
Environmental Protection Agency	X		X
Pacific Northwest River Basins Commission			X
Tennessee Valley Authority			X
ORGANIZATIONS AND FIRMS			
Amchem Products, Inc.	X		
Applied Biochemists, Inc.	X		
A-1 Spray Service		X	
Beak Consultants, Inc.	X		
Bellevue Journal American		X	
Broadmoor Golf Club	X		
Broadmoor Maintenance Commission	X		
Cascade Bass Masters Club	X	X	
Coalition to Save King County Lakes from Milfoil	X		
Columbia Basin Herald	X		
Constructors - Pacific Co.			X
Dow Chemical Co.	X		
Fall City Business and Professional Association	X		
Floating Homes Association	X		
Friends of the Earth	X	X	X
H. R. Spinner Co.		X	
Interclub Boating		X	
Lake Leota Community Club	X		

	Responded to January 1979 Questionnaire	Participated in January 1979 Public Workshop	Other Participation
ORGANIZATIONS AND FIRMS (con.)			
Lake Sammamish Community Club	X	X	
Lake Sammamish View Association	X		
Lake Sawyer Community Club	X		
Northlake Marina	X		
Northwest Bassmasters	X		
Northwest Marine Trade Association	X		
NuLife Fertilizers	X		
Olympic Peninsula Citizens Against Toxic Sprays	X		
Omak-Okanogan Co. Chronicle			X
Oroville Gazette-Tribune		X	
Pennwalt Corporation	X		
Queen City Yacht Club	X		
Sacajawea-North Roosevelt Community Club	X		
Save Our Union Bay Committee			X
Spokane Chronicle	X		
Thompson-Hayward Chemical Company		X	
Washington Bass Association	X		
Washington B.A.S.S. Federation	X		
Wheeler Yacht Sales	X		
Wilbur-Ellis Company	X		

INDIVIDUALS PARTICIPATING IN THE STUDY

	Responded to January 1979 Questionnaire	Participated in January 1979 Public Workshop	Other Participation
INDIVIDUALS			
Jesse Amador, Kent	X		
Mrs. William Barger, Bellevue	X		
Beth Bauer, Issaquah	X		
Mike Berriochoa, Kennewick	X		
Don Birdsall, Issaquah	X		
Calvin Bugbee, Issaquah	X		
Robert Buoy, Grandview	X		
Anne Buzy, Bellingham			X
John Callahan, Issaquah	X		
Bruce Campbell, Bellevue	X		
Melvin Campbell, Seattle	X		
Ruth Carson, Kent	X		
Richard Comes, Prosser	X		
Shirley Dahl, Bellevue	X	X	
Earl Davis, Issaquah	X		
S. A. Dawson, Seattle	X		
Josef Diamond, Seattle	X		
J. R. Fisher, Issaquah		X	
Mrs. Forrest Flashman, Seattle	X	X	
Daniel Flick, Louis	X		
W. L. Fundy, Seattle	X		
Harold Gallagher, Seattle	X		
Carl Gould, Seattle	X		
H. Godavari, Winnipeg, Manitoba			X
Barrett Green, Seattle	X		
Kent Gunnison, Pasco	X		
Bob Hammond, Tacoma	X		
Judy Hanson, Seattle	X		
F. Henry, Seattle		X	X
Richard Hofeditz, Issaquah	X		
Rosemary Horwood, Seattle	X		
Stanley Jones, Seattle	X		
J. H. Karwal, Bellevue		X	
Arthur Kuhn, Redmond	X		
Mrs. Alfred Lang, Issaquah	X		
Thomas Marshall, Eatonville	X		
James McDevitt, Bellevue	X		

	Responded to January 1979 Questionnaire	Participated in January 1979 Public Workshop	Other Participation
INDIVIDUALS (con.)			
Homer McNeill, Wenatchee	X		
Henry Meador, Seattle	X		
Jack Mitenbuler, Yakima	X		
Hal Morrill, Issaquah	X		
Richard Morris, Redmond	X		
Linda Mycek, Wauconda			X
Clarence Neilsen, Bremerton	X		
Thomas Pitts, Oroville	X		
John Purcell, Olympia	X		
Robert Purdue, Seattle	X		
Rodney Rakowicz, Centralia			X
Douglas Reed, Issaquah	X		
Ralph Reed, Elk	X		
Bob Resi, Oroville		X	
Douglas Scheumann, Seattle	X	X	
William Sheard, Bellevue	X		
Susan Strommer, Kent	X		
Albert Thorne, Renton	X		
W. J. Timberlake, Seattle	X		
R. Wayne Uht, Issaquah	X		
Ray Viser, Tonasket	X		
W. W. Wagley, Seattle	X		
William Watts, Seattle	X	X	
John Weeks, Seattle	X		
Bob Wells, Issaquah	X		
Richard Welsh, Issaquah	X		
Steven Williams, Lopez	X		

COMMENTS AND RESPONSES

The following questions and comments were received from individuals and groups in response to the January 1979 questionnaire which was circulated in conjunction with the January public workshops.

QUESTIONS AND COMMENTS	ANSWERS AND RESPONSES
General	
Plant holds fish, but it is hard to fish; stalls the engine, plugs cooling system, or catches around prop (Ray Pulling, Washington Bass Association). Problem with buildup of weed on boat prop, lose fishing gear in weeds (Frank Reinbold). Costly to boaters and property owners; dangerous to both fowl and animals (Melvin B. Campbell). Milfoil is taking over Lake Sammamish and inhibiting recreational activities and decreasing land value (Mrs. Alfred J. Long). Prevents me from swimming and water skiing in infested areas (Shirley J. Dahl). Physical danger to swimmers and water-skiers; limited access to accidents by patrol boats; danger to motors; interference with sail boats, canoeists, etc. (Frank C. Henry). Control of Eurasian watermilfoil appears to be important for enhanced recreation in the Columbia Basin Project (Arthur C. Johnson, Columbia Basin Herald).	We recognize the serious impacts of heavy watermilfoil infestations on recreational boating, swimming and fishing; its negative impact on shoreline esthetics and its potential safety hazard. The proposed control program will concentrate on areas which experience heavy recreation use.
Eurasian watermilfoil itself cannot be properly considered to be a "problem or potential problem." If there are use conflicts, they will be with plants as a whole and not merely one species (G. M. Zemansky, Friends of the Earth).	As a nonnative species, without natural controls, watermilfoil populations are rapidly expanding and presenting special problems not experienced with native plants.
The thrust of the question sheet is biased. The brochure had a similar bias as well as inaccuracies. Is it possible for the U.S. Army Corps of Engineers to upgrade its handling of this matter to meet minimum standards of professionalism? (G. M. Zemansky, Friends of the Earth).	Your comments have been considered in preparing the public brochure.
What is your distribution on this? Aware of others who did not receive it (G. M. Zemansky, Friends of the Earth).	The questionnaire was distributed to those on our mailing list for the Aquatic Plant Management Study. This includes Federal, state, and local agencies; elected officials; news media; various civic, professional, and business groups; environmental groups; universities and colleges; and individuals who have expressed interest in the study by attending meetings, writing, calling, etc. Anyone who desires can be added to the mailing list.
Precisely what was the purpose of this survey? (G. M. Zemansky, Friends of the Earth).	The purpose of the questionnaire was to provide a means for public input into the study. The questions reflected some of the basic issues the study was addressing.
We have lived on Lake Washington for 3 years and have noticed at least 200% annual growth in the milfoil in our area (W. L. Fundy).	Your comment has been noted.
Hope you can solve the problem. Really makes a mess in the summer and spreading (Richard Morris).	Your comment has been noted.

QUESTIONS AND COMMENTS	ANSWERS AND RESPONSES
General	
Problem did not exist until silt was left from overflow from neighbors creek (R. Wayne Uht). County drainage is emptying silt on my property. Watermilfoil seems to like the silt (Richard Morris).	Watermilfoil density can be correlated with the particle size of the area on which it grows with areas of finer particles having denser growths. The presence of fine silt would provide a good medium for watermilfoil growth.
How can I get rid of water lillies? (C. A. Pilcher).	Our Aquatic Plant Management Program does not address control of native species such as water lillies.
Lake Sawyer has developed a severe infestation of milfoil over the past 3 years (Mrs. Monet D. Leon).	We are aware of the infestation of Lake Sawyer.
Water is this state's most valuable asset. If it is lost, so is the state (Clarence W. Neilsen).	Your comment has been noted.
Swans that winter here feed on milfoil. The swans are the only wildlife that I know that could affect it (Clarence W. Neilsen).	Watermilfoil can be a food source for waterfowl.
You should have given credit to Dr. Peter Newroth of Province of British Columbia for most of the information on milfoil in the pamphlet (T. F. Mumford, Division of Marine Land Management, Department of Natural Resources).	The information in the pamphlet was drawn from a number of sources including Dr. Peter Newroth.
I am sure any improvements made in this area could be beneficial to the whole nation (Roy T. Lewis, Washington B.A.S.S. Federation).	Your comment has been noted.
I am interested in knowing where successful strategies for milfoil control and eradication have occurred (Stan Geiger, Beak Consultants, Inc.).	The Tennessee Valley Authority (TVA) has had a successful program for control of watermilfoil in TVA reservoirs. The Province of British Columbia, Canada, also has had extensive experience with watermilfoil control.
How about finding a commerical use for the stuff so that there would be some incentive for private industry to harvest it (Bob Hammond)? If harvested, could any use be made of the weed (Frank Reinbold)?	Studies have been made to determine the potential use of watermilfoil as forage. It has a high percentage of crude protein but is generally low in fiber. The cost of harvesting, drying, and transporting appear to limit commerical use as forage. Attempts to utilize milfoil as a source of xanthoplyll in chicken feed were not successfull. Initial studies indicate that it could be composted and used as a growth media for greenhouses. The economics of a commercial composting operation are not known.
Need for Prompt Action	
Between U.S. and Canada there is sufficient testing data. How about getting on with the job (W. J. Timberlake). Let's reduce the amount of local studies by utilizing the experience gained in other areas (Albert J. Thorne). We are all exhausted by your exhaustive research programs. You are doing all these studies, costing the taxpayers more money. You did not offer one solution we have not heard about for years. Something concrete should	We recognize the need for prompt action to initiate effective control and prevention programs. We anticipate that our final report and final environmental impact statement will be submitted to our higher authority by October 1979. The proposed control and prevention programs are scheduled to be operational in 1980. We have just recently completed the construction of a river barrier in the Okanogan River below Lake

Need for Prompt Action (con.)

be done; start operating (Mrs. F. L. Flashman). We must stop researching and move. Do something while it still may be possible to effect some answer to a problem greater than generally recognized (W. W. Wagley).

Eurasian watermilfoil control has been adequately researched from all angles. Why all this fuss about what to do (Richard M. Bailey, Amchem Products, Inc.)? Your local office has been studying this problem for almost two years and you are still a year or two away from doing anything about it. Problem gets bigger all the time. Maybe this is a typical bureaucratic way to build up the problem to larger proportions so that more and higher paid bureaucrats are needed to supposedly cure the problem. I sincerely hope that you cure the problem soon (Richard Welch).

Some private person used a chemical said to be Casoron to defoliate Union Bay. This was highly effective. It was action, while various government agencies, such as METRO, were conducting useless and inappropriate "studies." Further action may be necessary if government agencies continue to bumble (Wm. E. Watts). Get rid of it as soon as possible, we're the ones it hurts, owners of lakefront property (Mr. Earl Davis). With my own experience and knowledge of this aquatic weed, we don't want to get behind in our prevention of its spread (Robert Wayne Buoy).

Let's go (Don Dirdsal)! I feel time is of great importance. I urge a prompt discussion and swift action (Mike Berriochoa). Every effort should be made to speed up the program wherever possible (Homer L. McNeill). Eurasian milfoil is a serious threat to us here in Washington. We have to start controlling it before it gets out of hand (Gary W. Herron). Unless quick and proper control measures are taken within 6 months to a year, watermilfoil will be in the Columbia. Action must begin soon before this happens (Thomas A. Pitts). The longer the problem is studied, the larger it gets. The need for a good program is urgent (R. L. Harbert).

The rapid increase in growth of Eurasian watermilfoil in the last 2-3 years indicates that something must be done very soon to control and eventually eliminate it (Arthur H. Kuhn). The problem is growing rapidly. Please expedite action (Robert Copernall).

We certainly do recommend that the Eurasian watermilfoil be controlled (Marion Guenther, Sec., Greenwood Park, Grange #590).

Osoyoos to trap watermilfoil fragments moving downstream. That barrier is now operational. Our Waterways Experiment Station is continuing its research program to test new and existing methodologies in the detection, treatment, and eradication of watermilfoil colonies in uninfested areas. This program would continue through 1981 and would operate concurrently with the control and prevention programs.

Choice of Control Methods

Techniques for the control of the Eurasian watermilfoil should be the most effective and quickest. Don't fool ourselves about trying to harvest the weed. It would seem the chemical 2,4-D would be the quickest and most effective (Daniel R. Flick). Chemical controls have been used both in Lake Osoyoos and Banks Lake. Lake Osoyoos has shown good results. Banks Lake drawdown has not been tested. Should be a good control over an annual drawdown for a given number of years (Robert A. Shiveley, Washington State Parks). Chemical treatment would be best. Should be done in spring before water is drawn from lake to water lawns. I have tried cutting and raking weed out - only short-term answer (Hal W. Morrell).

Why can't you use the chemical 2,4-D to keep the plants down and keep them from spreading to other lakes while you decide if other methods might be feasible (Bill Eads, Cascade Bass Masters Club). The use of Casoron last year did not damage fish or wildlife in the area. Since this is true, why not do the simple and inexpensive thing and use it in the future; meaning right now (Dr. Harold E. Gallagher). Chemical means can eradicate the milfoil and it is a waste of money and time to use other methods (Barrett Green).

I feel the use of chemicals should not be considered due to health problems that may be posed for people using these waters (Martha Vogt). Last year I believe Broadmoor golf course was damaged by chemicals put into Lake Washington (Don G. Abil, Jr., Broadmoor Maintenance Commission). It would be a foolish move for us to continue alteration of our environment with herbicides. These materials accumulate and affect other parts of the living system of which we as people are a part (Steven Williams).

Under no circumstances am I in favor of bringing grass carp into the state to control the plant. Almost certainly the carp would spread to lakes managed for specific species and would compete with game fish (Fenton Roskelley, Outdoor Editor, Spokane Chronicle). Use extreme care with biological control; these agents should be thoroughly researched. We don't want something introduced that will cause a bigger problem in the future (John R. Hoak). Amur fish are available, they eat all kinds of weeds, they don't take over the lake, no water need be poisoned, no environmentalist can bitch, the fish work for years quietly (Marshall Bingham). The people of Thailand and Indonesia farm their lakes for fish production. Even carp are preferable to weed takeover. Might test on small lake (Max W. Wilson).

Milfoil appears to be spread primarily by boaters and fishermen. This group should be subject of an intensive public education effort (Robert McCoy, Sun Lake State Park). Need more public education

We have considered all your concerns. The tentatively recommended control and prevention programs include a range of control methods coupled with public education and training programs. The recommendations for specific methods for specific areas were made after considering the local site conditions, purpose of the treatment, and size of the treatment area. The final decision on the treatment method will be made in cooperation with the individual local governments. Certain methods have been eliminated from consideration because of their environmental impacts, costs, lack of effectiveness, or because they need further testing.

Choice of Control Methods (con.)

on proper control of the weed (Bob Wells). There appears to be a need for a massive community education program with much broader consumer representation (Judy T. Hanson).

The mechanical harvesting seems a joke because it would be impossible to collect every bit of milfoil that is cut. If Casoron is sold over the counter, it could not be so bad a chemical (Richard Welsh). The use of plastic screens and bottom barriers seems attractive, but should be examined critically. Audubon magazine reports increasing PCB pollution in Everglades National Park. The source is plastic sheeting used in farms bordering the park (Ruth Carson). I feel that integrated control methods may be the best answer and perhaps the least expensive and long lasting (Marguerite Neilsen).

Tried to pull it up, that didn't work. Tried cutting with a chain, that didn't work. Next step poison, but afraid of effect on fish (Calvin A. Bugbee). We notice we get the most floating milfoil on Monday and Tuesday after a busy boating weekend. Could it be possible to ban power boats from the areas until some solution is found for the problem (Mrs. William E. Barger). During the summer of 1978 there was an unauthorized application of herbicides in the Union Bay area of Lake Washington. There was a dramatic reduction in milfoil along our beach and around our dock. We saw absolutely no evidence of other damage to aquatic life (Henry T. Meador).

Where my dock float is, I rake it up - lots of work and not too effective. Maybe a chemical could be bought, like a lawn weed killer (Carl F. Gould). Last July I placed two pieces of hardware cloth over the plants in eight feet of water. Had success but think the 1/4-inch mesh allowed too much sunlight to reach the plants (John Weeks).

YOUR COMMENTS

NAME: _____ PHONE: _____

ADDRESS: _____

REPRESENTING: _____

_____ I want to continue receiving information on this study.

_____ I do not wish to receive further information on this study. Please remove my name from the mailing list.

DEPARTMENT OF THE ARMY
SEATTLE DIST., CORPS OF ENGINEERS
P. O. BOX C-3755
SEATTLE, WASHINGTON 98134

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Seattle, Washington 98124

STATE OF WASHINGTON
Dixy Lee Ray
Governor

DEPARTMENT OF ECOLOGY
Olympia, Washington 98504 206/753-2240
Wilbur G. Hallauer, Director

August 4, 1977

Colonel John A. Poteat
Department of the Army
Seattle District
Corps of Engineers
P.O. Box C-3755
Seattle, Washington 98124

Dear Colonel Poteat:

We appreciate the efforts of the Seattle District Corps of Engineers in helping to sponsor the Eurasian Water Milfoil workshops in Washington State and in sharing the expertise of the Waterways Experiment Station.

The purpose of this letter is to recommend establishment of a milfoil prevention and control program in Washington State. We want to emphasize the urgency of preventing the infestation of milfoil into the Columbia River system. Washington State has the unique opportunity of preventing the spread of milfoil into the Columbia in which case we can avoid a massive control effort such as the one required in the Tennessee Valley Authority impoundments.

In anticipation of a Corps of Engineers program, the Department of Ecology is committed to an interim aquatic weed program in Lake Osoyoos. The program presently consists of search and identification efforts, control measures, and a public information program.

The Department will act as the statewide sponsor for local milfoil control programs. We intend to act as an "umbrella" sponsor and in this capacity will actively seek local sponsors to contribute 30 percent matching funds. We will also seek legislative authority for the State to contribute 30 percent funding. In areas where the Federal interest overrides State interest, we may seek 100 percent funding from the Corps of Engineers.

The importance of acting quickly in a milfoil prevention and control program has been discussed, and we would recommend that action be taken to expedite the review process so that the prevention and control program can begin. If we can assist in expediting the process, please contact us.

If you have any questions, please feel free to contact me.

Sincerely,

Wilbur Hallauer

Wilbur G. Hallauer
Director

EXHIBIT 2

STATE OF
WASHINGTON

Dixy Lee Ray
Governor

DEPARTMENT OF ECOLOGY
Olympia, Washington 98504 206 753 2240

Wilbur G. Hallauer, Director

April 4, 1979

Colonel John A. Poteat
Department of the Army
Seattle District
Corps of Engineers
P.O. Box C-3755
Seattle, WA 98124

Dear Colonel Poteat:

The purpose of this letter is to reaffirm the commitment made to you in my letter of August 4, 1977, that the Department of Ecology intends to participate in a cost-sharing aquatic weed control program with the Corps of Engineers in the State of Washington. It is my understanding that this reaffirmation is needed for inclusion in the design memorandum and environmental impact statement currently being prepared by your staff.

The department intends to act as a statewide broker or "umbrella" sponsor for local aquatic weed control projects and, in this capacity, will actively seek local sponsors to contribute 30 percent matching funds. In areas where federal interest overrides state interest, we will seek 100 percent funding from the Corps of Engineers.

If we can assist you further or if you have any questions, please feel free to contact me.

Yours truly,

Wilbur G. Hallauer

Wilbur G. Hallauer
Director

EXHIBIT 3

appendix d

FISH AND WILDLIFE SERVICE REPORT

Ecological Services
2625 Parkmont Lane, S.W., Bldg. B-3
Olympia, Washington 98502

July 2, 1979

Lt. Colonel Maxey B. Carpenter
Acting District Engineer
Seattle District, Corps of Engineers
P.O. Box C-3755
Seattle, WA 98124

Dear Lt. Colonel Carpenter:

This constitutes the draft report of the U.S. Fish and Wildlife Service on the fish and wildlife resources in the areas proposed for aquatic milfoil control in Washington, the effects the proposed project would have on these resources and compensation and mitigation measures necessary to replace or offset those anticipated negative effects. This report has been prepared under the authority and in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401 as amended; 16 U.S.C. 661 et. seq.). It is provided to assist your agency in preparing a draft feasibility report.

These comments are based on published and unpublished data relative to the fish and wildlife resources of the proposed treatment sites, Washington State Department of Ecology, environmental impact statement "Control of Water Milfoil in Areas of Lake Washington," and information extracted from existing literature on ongoing studies of the positive and negative benefits of Eurasian watermilfoil (Myriophyllum spicatum) to fish and wildlife resources, the effects of milfoil removal and the impacts of the recommended control measures on fish and wildlife resources. This report supplements and updates our Service planning aid letter dated December 18, 1978.

Project Location

The proposed treatment areas for 1980 are as follows (Fig. 1):

I. Lake Washington. Lake Washington has a surface area of about 22,000 acres with an average depth of 100 feet and a maximum depth of 210. It has many shallow embayments which are ideal for aquatic plant growth. Specific areas within Lake Washington to be treated are:

Union Bay. Union Bay is located between the main body of Lake Washington and the ship canal to Lake Union. It has approximately 350 surface acres of which about 200 are heavily infested with milfoil. The main infestation occurs between the navigation channel on the south and the waterlily (Nymphaea odorata) patches on the north. Milfoil has not grown in the navigation channel because of its depth but the area south of the channel is also infested.

Union Bay is a very high use area for recreational boating, swimming, and water skiing. Milfoil has obstructed this use for waterfront property owners, University of Washington boaters, and the general public.

The proposal for Union Bay is to treat 100 foot wide channels along the shoreline of Webster Point where high usage corresponds with heavy milfoil infestation (a distance of approximately 1,000 yards), from the University of Washington boat docking area and crew house to open water, and from the southern bay area to open water. The total treatment area for Union Bay would be approximately 17 acres.

Lake Forest Park - Kenmore Area. This area is located at the north end of Lake Washington and includes a large number of private boating structures, the King County Logboom Park, and an area of commercial water use. Milfoil covers over 100 acres and has obstructed the navigability of the area and threatens public recreation at the county park.

The proposal for this area is to treat a 100 foot wide channel along the shoreline for approximately 800 yards fronting the areas listed above and to treat the area of the county park necessary to maintain public recreation (see figure 5). The total treatment for this area would be approximately 14 acres.

The acceptable treatment methods would be mechanical harvesting and the application of 2,4-D. In addition to these methods, the county park could make use of endothall, casoron, diquat or bottom shading.

Juanita Bay. Juanita Bay is located on the east side of Lake Washington just north of the city of Kirkland. It contains a larger number of private boating structures and the Juanita Beach County Park. Milfoil covers approximately 50 acres and has obstructed private boating in the bay and public swimming at the county park.

The proposal for this area is to treat a 100 foot wide channel along the shoreline where high usage corresponds with heavy milfoil infestation (approximately 500 yards) and to treat the water area of the county park (see figure 6). The total treatment area for Juanita Bay would be approximately 7 acres.

Nelson Point - Kirkland Area. This area is directly south of Juanita Bay and has a high density of private boating structures. Milfoil has infested the littoral zone and is obstructing swimming and boating.

The proposal in this area is to treat a 100 foot wide channel along 1,700 yards of the shoreline (see figure 7). The total treatment would be approximately 12 acres.

Yarrow Bay. Yarrow Bay is located on the east side of Lake Washington south of the city of Kirkland. It contains a large number of private botating structures, two fair size marinas, and some important wetlands. Milfoil has infested approximately 25 acres of the littoral zone and is obstructing boating and swimming.

The proposal for this area is to treat a 100 foot wide channel along the shoreline where high usage corresponds with heavy milfoil infestations (approximately 900 yards) and provide a channel to deep water if necessary (see figure 8). The total treatment in Yarrow Bay would be approximately 6 acres.

1.05.1.6 Cozy Cove. Cozy Cove is located directly west of Yarrow Bay and contains a large number of private boating structures. Milfoil has infested approximately 40 acres in the cove and has obstructed boating and swimming.

The proposal for Cozy Cove is to treat a 100 foot wide channel along the shoreline for approximately 1,400 yards (see figure 9). The total treatment for Cozy Cove will be approximately 10 acres.

1.05.1.7 Fairweather Bay. Fairweather Bay is located directly west of Cozy and contains a large number of private boating structures. Milfoil has infested approximately 40 acres in the bay and has obstructed boating and swimming.

The proposal for Fairweather Bay is to treat a 100 foot wide channel along two sections of shoreline totalling approximately 2,500 yards (see figure 10). The total treatment for Fairweather Bay would be approximately 17 acres.

1.05.1.8 Seward, Madrona, and Pritchard Parks. These are Seattle city parks located on the west side of Lake Washington. They are high use public recreation areas and are being obstructed by milfoil growth.

The proposal for these parks is to treat the swimming areas to a degree that will adequately maintain public recreation. The total area to be treated in these three areas is approximately two acres.

1.05.2 Lake Union. Portage Bay is the only area proposed for initial treatment in Lake Union. It is located directly west of Union Bay and contains approximately 10 acres of milfoil growth.

The proposal for Portage Bay is to treat the milfoil blocking access to the navigation channel from the southern end (see figure 11). The treatment area would be approximately 4 acres.

1.05.3 Lake Sammamish. The surface area of Lake Sammamish is about 5,000 acres, with a maximum depth of 100 feet. It discharges into Lake Washington by way of the Sammamish River.

The only area proposed for initial treatment in Lake Sammamish is the Washington State Park. This is a high use public recreation area which is being obstructed by milfoil.

This park is located at the southern end of the lake. It has a 500-foot long swimming beach and a boat launching ramp.

The proposal for the park is to treat the swimming area to a degree that will adequately maintain public recreation, and to provide for access from the boat ramp to open water. The total treatment area would be less than two acres.

II. Osoyoos Lake. The northern half of Osoyoos Lake is within the boundaries of Canada and has significant colonies of milfoil which are a constant source of fragments for the southern (U.S.) half. The southern half of Osoyoos Lake has only small colonies and scattered milfoil plants but is a source of fragments for the Okanogan River.

The proposal for Osoyoos Lake is to immediately treat patches of milfoil identified by aerial and ground surveillance. The object of this treatment will be the complete elimination of known colonies.

The acceptable methods of treatment on Osoyoos Lake would be the application of 2,4-D, use of a suction dredge, rotovating or hand pulling depending on colony size and on-site conditions.

III. Okanogan River. The Okanogan River drains Osoyoos Lake and is therefore subject to fragmented milfoil floating downstream. Small colonies of milfoil have been reported in the upper river channel.

The proposal for the Okanogan River is to establish a barrier structure downstream of known milfoil colonies to slow the spread of fragments; and to treat colonies in the river channel identified by aerial and ground surveillance to eliminate sources of fragments.

The acceptable methods of treatment in the river channel would be the application of 2,4-D, use of the suction dredge, rotovating or hand pulling, depending on the colony size and on-site conditions.

IV. Other Water Bodies. Eradication of milfoil colonies identified by aerial or ground surveillance would be attempted in those areas which directly threaten navigable waters. These waters will have to be identified prior to treatment so biological evaluation can be completed and treatment restrictions considered (i.e. timing) to protect fish and wildlife.

Project Description

The proposed project employs two techniques for control; (1) mechanical and (2) chemical.

Mechanical Control. Mechanical control will include the removal of affected plants from the water to reduce biological oxygen demand and nutrient release. Containment booms will be used in harvesting and rotovating operations to prevent the spread of milfoil fragments caused by the operation.

Chemical Control. Chemical treatment would be done by certified applicators. Chemicals would be applied at the minimum concentration required to control milfoil to prevent large amounts of chemicals being introduced into the aquatic system and to take advantage of the selective properties of the chemicals (leave as much native vegetation as possible unaffected).

Public notification of chemical usage and appropriate restrictions to water use would be extensive to prevent public exposure to the herbicides. The notification would extend to those areas outside the treatment area which could be subject to herbicide drift.

Site specific considerations would be important in the selection of chemical formulation (e.g. granular herbicide would be used in those areas in which drift could be a problem).

Chemical treatments would be timed to take advantage of the period of maximum susceptibility of milfoil whenever possible. This will provide more efficient control and, since the optimum period is early in the year during rapid growth (before maximum biomass is reached) would minimize the amount of aquatic vegetation decomposing in the water. Early treatment may not be possible in all cases, however. In important salmon areas, treatment would be delayed to coincide with times of low salmon usage.

In areas subject to periods of low dissolved oxygen concentrations, chemical treatment would be done in stages to prevent adverse impacts to aquatic life which could be cause by a large biological oxygen demand.

Vegetation: (Table 1)

Western Washington Lakes

Lakes Washington and Sammamish and Union Bay contain extensive areas of shallows (less than 20 ft. depth) which historically supported large populations of submergent aquatic vegetation (SAV) which included Potomogeton berchtadii and crispus, waterlily (Nyphaea odorata) spatterdock (Nyphar polysepalum) and coontail (Ceratophyllum spp.). milfoil (Myrophyllium spicatum) is a recent invader.

Wetlands along the shores of Lake Washington were censused and classified in 1979 (Ellman and Schuett-Hames, unpub.) into six plant communities: (1) Spatterdock-Water Lily; (2) Cattail; (3) Reed Canarygrass; (4) Sedge-Buttercup; (5) Spirea- Reed Canary Grass; and (6) Willow-Black Cottonwood-Red Alder. The same plant communities are prevalent in the wetlands in Sammamish Lake and Union Bay.

Submergent aquatic vegetation (SAV), including aquatic milfoil has been shown to have significant value for both fish and wildlife. Emergent plant communities adjacent to and incorporated in wetlands also have significant values, particulary to spinyray and other shallow feeding fish species.

Eurasian milfoil, the target species of the proposed control program, is an introduced species with positive and negative impacts to fish and wildlife. Its description, growth patterns, and positive and negative values to fish were covered in our December 18, 1978 planning aid letter.

Lake Osoyoos - Okanogan River:

Lake Osoyoos and the Okanogan River are continuations of Okanogan Lake in Canada. The submergent, emergent and wetlands habitat species are continuous through the Okanogan species with deviations dependent on lake or stream habitat water temperature and water depth. Macrophytes that

contribute to fish and wildlife which could be affected by control programs include (Flodea canadensis) coontail (Ceratophyllum demersum), Potomogeton crispus, P. pectinatus, P. richardsoni, P. natans, Najas sp. and Chara sp.

Emergents that could be effected by chemical control programs include waterlily, cattail and sedge marshes.

Benthos. The presence of benthic species and other fauna are influenced by aquatic vegetation.

Lake Washington. White (1975) did an extensive survey of the littoral zone of Lake Washington in a study of the influence of piers and bulkheads on the aquatic organisms of Lake Washington. He found that areas which supported the greatest faunal abundance were also the areas with the largest amounts of organic matter; therefore an increase in the abundance of organic matter derived from either autochthonous or allachthonous sources is likely to have a profound effect on faunal abundance and richness. Studies in stream ecoystems by Chapman and Demory 1963 and Minshall, 1967, emphasize the importance of allochthonous plant material in determining the abundance and distribution of benthic materials. White found that benthic abundance was significant in open areas during the fall when vegetative growth (i.e. organic matter) was abundant.

A systematic list of the benthic microinvertebrates (White, 1975) is presented in Table 3.

Lake Sammish - Union. Although Lake Sammamish and Union Bay are separate bodies of water by name the benthic communities are thought to identical for similar locations (i.e. water depth, vegetation, freshwater inflow and water temperature. The premise that benthic communities increase with increased faunal activity is consistent and should be a factor in control activities.

Fish:

According to Wydoski (1972b) 36 species of fish are now present in Lake Washington (Table 4) with the following 12 resident fish species either common or abundant.

Sockeye salmon	Oncorhynchus nerka
Peamouth	Mylocheilus caurinus
Northern squawfish	Ptychoeheilus oregonensis
Yellow perch	Perca flavescens
Brown bullhead	Ictalurus nebulosus
Prickly sculpin	Cottus
Longfin smelt	Spirinchus thaleichthys

Carp	Cyprinus carpio
Largescale sucker	Catastomus machrocheilus
Three-spine stickleback	Gasterosteus aculeatus
Largemouth bass	Macropterus salmoides
Black crappie	Pomoxis nigromaculatus

The first seven species in this list are the most common. The last five species are restricted to weedy bays and undeveloped shorelines. Suckers are a long-lived slow-growing species that consume only benthos and are common throughout the lake. Large scale suckers are less abundant than squawfish and are a minor component of the total fish production of the lake.

A summary of fish species in the shallow areas of the lake is given by Burgner (1976). Sockeye and kokanee habitats and spawning concentrations are removed from these sites because sockeye and kokanee are limnetic (offshore) planktivores and spawn mostly in the Cedar River. Migrating yearling coho and juvenile chinook move through the areas in the spring. Adult coho, chinook travel through the summer and fall to spawn in tributaries to the Sammamish and Cedar Rivers. Juvenile salmon, migrating from these tributaries, pass through the area in the spring as they travel through the Puget Sound area to the ocean. Rainbow and cutthroat trout are present in the lake but tend to inhabit the more open exposed shoreline areas of the lake. At present, the population levels of trout in Lake Washington are small.

The valuable spinyray species found in Lake Washington are yellow perch, brown bullhead, black crappie, and largemouth bass. Of these, yellow perch and bullhead are the most abundant. Yellow perch are found throughout the lake but the others are restricted to the shallow, unexposed areas of the lake (Union Bay, Kenmore area, Juanita and Cozy Cove, Yarrow Bay, Mercer Slough, Renton, and Andrews Bay). Brown bullheads are abundant in these areas. Except at time of spawning, yellow perch are found in deeper offshore areas. Black crappie and largemouth bass are inshore but prefer habitat with substantial cover (overhanging brush, aquatic plants, logs, brush, and docks). These valuable spinyray species are dependent on aquatic vegetation, and a viable benthic community for cover, protection and food.

Yellow perch primarily feed on small crustaceans, mollusks, aquatic insect larvae and nymphs and small fish. In a study conducted in northern California fish remains were only found in 13.5 percent (37 of 357) stomachs examined. Fish did not enter the diet until about their second year (Coots, 1966).

Brown bullhead usually feed near the bottom, foraging most actively in the evening and at night (Raney and Webster, 1940 from Emig, 1966). Young eat

an assortment of insects and crustaceans with some algae and diatoms included. As the fish grow they become omniverous feeding on mollusks, insect larvae, fish and crustaceans, algae and other plants (Emig, 1966).

Black crappie studies have shown that they are very dependent on other fish species for food with some feeding on shrimp and amphipods where available (Goodson, 1966).

Juvenile largemouth bass feed largely on small crustaceans. As they grow they change their diet to insects. Adults eat mainly fish, but they also take annelids, crustaceans and mollusks (Sigler, 1959).

The food habits of these four species are presented to demonstrate the value of the benthic fauna to the spinyray fishery in Lake Washington. Most of the spinyray species are common in Union Bay and Lake Sammish and constitute a large portion of the resident species fishery.

Lake Osoyoos - Okanogan River:

The fish populations of the Okanogan River system consists of both anadromous and resident fish species. Anadromous fish populations in the Okanogan River system include summer-run chinook (Oncorhynchus tshawytscha), sockeye (Oncoryhnchus nerka), and steelhead trout (Salmo gairdneri). Use by coho salmon (Onorhynchus kisutch) is minimal. The present fishery is in a sensitive ecological position. Fish populations in the upper Columbia River Basin are less than in former years, mainly due to irrigation, power, local bank protection and flood control developments, and domestic water needs. The chief constraints to management of the Okanogan River fishery resource are physical obstructions, which include falls and dams which block upstream migration on major tributary streams, low flow conditions which limit spawning and rearing habitat during dry periods, and high water temperatures which coincide with upstream migration periods and interfere with timing important to spawning and fry survival.

Field observations conducted by the Washington Department of Fisheries and Game identified the major spawning beds within Okanogan River. The estimated annual spawner return is summarized as follows:

Entire Okanogan River System

Species	Average No. of Return Spawners - 1965 to 1974
Chinook salmon	1,900
Sockeye salmon	46,000
Steelhead trout	300 3/

3/ Data provided by U.S. Fish and Wildlife Service, period of observation not specified.

Resident game fish populations include rainbow, brook, cutthroat, Dolly Varden, and brown trout; plus whitefish, bass, crappie, and sunfish. In addition, there is a high density population of nongame fish species such as sucker, chub, squawfish, catfish, and carp. A listing of fish known to occur in or adjacent to the project is included in Table 5.

Wildlife:

Lake Washington:

Birds. Waterfowl, marshbirds, and shorebirds utilize most of the shallow or heavily vegetated areas in all of the specifically identifed proposed treatment sites. Other birds such as flycatchers, other insectivores, and raptors derive secondary benefits because of a food base either supported by or generated by the faunal community. In 1972 the Christmas count identified 119 species of birds (Table 6) on or around Lake Washington-Sammamish-Union Bay. Of these, 66 species are water dependent or derive secondary benefits from the water. A major portion of these benefits come from macrophytes or macrophyte generated benefits. Insects, schooling small prey fish and amphibians are drawn to heavy macrophyte stands and become a food source for certain birds. Other birds using macrophytes for cover, foot, etc. become prey species for avian and some mammalian predators.

The adjacent wetlands are used as nesting, brood rearing and loofing sites for an undetermined number of these species.

Lake Osoyoos and Okanogan River:

Birds. Natural river edge vegetation is a life-sustaining part of bird habitat in the Okanogan Valley. Brush river edge understory, composed largely of woody plants, provides both cover from predators and a food resource in the form of fruits, berries, seeds, and insects.

In winter, the woody understory stands above the snow cover, which compacts and covers soft herbaceous annual and perennial plants. During this period, the woody understory is a key to bird survival: late season fruits, berries, and seeds are above the snow cover and provide food in a time of scarcity; the thicket provides cover from predators and weather, and the moderating influence of the river is a refuge from periods of severe winter cold.

The Washington Department of Game completed a comprehensive study on upland bird populations in connection with the Wells Dam Hydroelectric Project. Because of geographic proximity and similarity of habitat types, the study findings are applicable to the general area. The study was designed to determine abundance and density of upland bird species on 46 miles of riverbank and bottom lands, including a 14-mile stretch of the

Okanogan River upstream from its confluence with the Columbia River. The study shows that the survival and abundance of most upland game bird species depends on river edge habitat. Field counts show seasonal use patterns for valley quail living within 1-1/2 miles of the river.

Waterfowl and shorebirds nest along tributaries, oxbows, and the main stem of the Similkameen and Okanogan Rivers. While the valley is a componenet of the Pacific flyway, hunting pressure is light and predicted to remain so. More intensive management of the waterfowl resource is likely. Plans exist for encouraging increased goose and duck production both in the Similkameen and Okanogan Valleys. A number of resident and migratory songbirds depend on the river course for cover, food, and reproduction (Table 7).

Mammals. Muskrats, beaver, mink, and river otter inhabit Palmer Lake, the Okanogan River, and its tributaries. These fur animals support and would continue to support moderate trapping pressure. The Oxbow Island located in southwest Omak supports small mammals typical of undisturbed riverbottom habitat. As such, this area is unusual due to its proximity to the developed town of Omak. A list of mammal species may be found in Table 8. A list of known amphibian may be found in Table 9.

Anticipated Fish and Wildlife Impacts of the Project

The potential for major environmental impacts of an aquatic plant control program in the proposed project areas could be significant. The studies referenced in the resources section of this report demonstrate that the major aquatic milfoil concentrations are in the same locations or adjacent to the following:

1. Major nontarget macrophyte concentrations.
2. Largest wetland areas of Lake Washington.
3. Highest abundance of benthic invertebrates during summer and fall.
4. Major habitats and concentrations of valuable spinyray game fish species.
5. Migration route of juvenile salmonids.
6. Waterfowl and marshbird concentration areas.

The types and amounts of impacts are regulated by the control methods, time of control and the extensiveness of the control.

The types of controls anticipated were discussed in our December 18, 1978 planning aid letter. This discussion was general and did not address the specifics. The following is a site specific evaluation of the proposed project and recommendations regarding the identified treatment techniques.

Union Bay. The project outline identifies a treatment of area of approximately 17 acres in 100 foot wide channels along the shoreline of Wester Point (figure 2). Acceptable methods are 2,4-D and mechanical harvesting.

In our PAL we noted studies that showed 2,4-D acid equivalent at 20 lbs. per acre in attaclay granules resulted in a 95 percent reduction in milfoil, was relatively nontoxic at those levels to eastern oysters, blue crab, softshell clams and certain spinyray fish, has mixed but limited negative effects to fish food organisms and had a low mean-percent-mortality on a variety of salmonids. Also, at 20 lbs/acres the 2,4-D was relatively selective in killing milfoil while not having significant effects of red head, sage pondweed, and widgeon grass.

We also addressed our concern of spraying with 2,4-D since it is a synthetic plant-growth regulating hormone that effects most broad leaf plants.

In our PAL, we also noted our concern with the nonselective nature of mechanical harvesting and the rapid rate of recurrence.

Webster Point is an identified high benthic invertebrate area, has a diverse macrophyte community, and has good spinyray fish use. We believe the negative impacts would be less using a 2,4D attaclay formulation and would suggest against mechanical harvesting in this area. The application should be timed to have the least interference to juvenile salmonid activity in the bay.

Lake Forest Park - Kenmore Area:

The area south of the proposed treatment site is a major salmonid migration route to the Sammamish River, supports good populations of spinyray fish and is a waterfowl nesting and wintering site. The specific project site and extent would not preclude either mechanical or 2,4-D BE treatment.

We have concerns with the uses of endothall, casaron, or diquat. All three chemicals have demonstrated less selectivity in plant control and/or greater negative effects to fish, amphibians, invertebrates and/or people. Also, the methods of application usually include a liquid carrier and spray which increases the potential for drift and nontarget treatment and accidents. If given an opportunity to review individual county park proposals we would recommend against these chemicals even though they are legally registered for this use.

Juanita Bay. Because of identified benthic values, and spinyray distribution we would make the same recommendation as for Webster Point and again stress our concern with the use of endothall, diquat, or casaron.

Nelson Point. We concur with the proposed acceptable methods.

Yarrow Bay. Yarrow Bay is a significant wetland with identified salmonid activity (believed to be rainbow trout) in the slough. The shallow area is a waterfowl concentration area at times. Bald eagle are known to feed on fish in the area.

Because of the intrinsic values of the site treatment should be species selective and coordinated with salmonid activity.

Cozy Cove, Fairweather Bay, and Lake Union (Portage Bay). Recommended programs are acceptable.

Seward, Madrona, and Pritchard Parks. Again we stress our concern over the uses of endothall, casaron, or diquat. Bottom shading destroys all flora and much fauna and is less acceptable to our concerns than more selective methods.

Lake Sammamish:

Washington State Park. We have the same concerns over proposed treatment as in Seward, etc. parks.

Lake Osoyoos and Okanogan River:

Impacts related to the proposed prevention plan in the Okanogan Basin (Osoyoos Lake and the Okanogan River) will probably be greater from the proposed suction dredge, and rotovating programs. Both techniques are nonselective and will not only destroy all submergent aquatic vegetation but will disturb if not destroy the benthic community. A secondary impact will be downstream pollution from silt generated by the activities.

A review of the success of these programs in British Columbia indicate that the results are still less effective than 2,4-D has been (95% kill) and the impacts greater. Based on these concerns we would recommend that these techniques only be used when it is demonstrated that 2,4-D attaclay particle treatment is impracticable.

Other Water Bodies. All areas to be treated should be identified, mapped and submitted to concerned agencies and persons for review before any treatment is allowed. Anything less would constitute speculative approval of a chemical program or unregulated habitat manipulation or destruction.

We would be opposed to any program that places the determination of what should or should not be chemically treated outside of the control of a site specific permit and review process.

Mitigation and Compensation Recommendations

Chemical Control:

1. The Corps of Engineers should condition their funding of local governments to restrict chemical treatment to 2,4-D acid equivalent formulations incased in attaclay particles. Funding should not support the following:

   a. Aerial applications of any liquid formulations.

   b. Use of diquat, casaron, endothall or any other identified herbicides.

2. Corps of Engineers require post treatment monitoring to determine:

   a. The percent and duration of the milfoil control.

   b. The effect on nontarget plant species.

   c. Fish or invertebrate kills.

3. Rehabilitation funds be set aside and held for a period of one growing season. Funds would be used to:

   1. Rehabilitate nontarget macrophytes if they show no recovery within the first growing season.

   2. Compensate for any fish or invertebrate kills that are shown to be a direct effect of the treatment program.

4. Investigate the feasibility of treating mouths of known anadromous spawning streams to disperse possible predator fish populations and enhance juvenile salmonid migration success. Discussions should include Washington State Departments of Game and Fisheries, National Marine Fisheries Service, Fish and Wildlife Service, and the Corps Environmental Resources Section.

Mechanical Control:

1. Mechanical control should be restricted to cutting devices. The use of rototillers, suction dredges, or other devices that disrupt the bottom strata and destroy benthos should not be funded with federal

monies.

2. Mechanical control not be conducted on a continuing basis in areas with identified *nontarget* species, benthic invertebrates, or spinyray sport fisheries.

Sincerely,

George L. Capp
Field Supervisor

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LIST OF TABLES

Table 1. Plants of Lake Washington.

Coontail	*Ceratophyllum demersum*
Musk grasses	*Chara* or *Nitella*
Spike rush	*Eleocharis palustris*
Common elodea	*Elodea canadensis*
Aquatic milfoil	*Myriophyllum spicatum*
Naida	*Najas* sp.
	Phalaris arundinacea
Bigleaf pondweed	*Potamogeton amplifolius*
Slender pondweed	*Potamogeton berchtoldii*
Redhead-grass	*Potamogeton richardsonii*
Fern pondweed	*Potamogeton robbinsii*
Ribbonleaf pondweed	*Potamogeton epihydrus*
Sago pondweed	*Potamogeton pectinatus*
Whitestem pondweed	*Potamogeton praelongus*
Water-starworts	*Callitriche* spp.
Riccia	*Ricciocarpus natans* (L.) Corda
Common Horsetail	*Equisetum arvense* L.
Giant Horsetail	*Equisetum telmateia* Ehrh.
Lady Fern	*Athyrium felix-femina* (L.) Roth
Deer-Fern	*Blechnum spicant* (L.) Roth
Shield-Fern	*Dryopteris* sp. Adans
Bracken Fern	*Pteridium aquilinum* (L.) Ruhn
Rocky Mountain Juniper	*Juniperus scopulorum* Sarg.
Hackmatack	*Larix occidentalis* Nutt.
Lodgepole Pine	*Pinus contorta* Dougl.
Douglas Fir	*Pseudotsuga menziesii* Pursh.
Western Hemlock	*Tsuga heterophylla* (Raf.) Sarg.
Black Cottonwood	*Populus trichocarpa* T. & G.
Willow	*Salix* spp. L.
Sweet Gale	*Myrica gale* L.
Red Alder	*Alnus rubra* Bong.
Hall's Birch	*Betula glandulosa* var. *halli* (Howell) Hitch.
Hazelnut	*Corylus cornuta* Marsh.
Nettle	*Urtica dioica* var. *lyalli* (Wats.) Hitchc.
Water Smartweed	*Polygonum amphibium* L.
Sheep Sorrel	*Rumex acetosella* L.
Spatterdock	*Nuphar polysepalum* Engelm.
Water-lily	*Nymphaea odorata*
Buttercup	*Ranunculus* spp. L.
Water-cress	*Rorippa nasturtium-aquaticum* (L.) Schinz & Thell
Fringecup	*Tellima grandiflorum* (Pursh.) Dougl.
Gooseberry	*Ribes* sp. L.
Western Serviceberry	*Amelanchier alnifolia* Nutt.
Hawthorn	*Crataegus* sp. L.
Indian Plum	*Osmaronia cerasiformis* (T. & G.)
Purple Cinquefoil	*Potentilla palustris* (L.) Scop.
Pacific Silverweed	*Potentilla pacifica* Howell
Bitter Cherry	*Prunus emarginata* var. *mollis*

Table 1. (Continued)

Chamisso's Cotton	Eriophorum chamissonis C.A. Mey
Hardstem Bulrush	Scirpus acutus Muhl. ex Bigel.
Bulrush	Scirpus microcarpus Presl, Rel. Haenk
Creeping Softgrass	Holcus mollis L.
Reed Canary Grass	Phalaris arundinacea L.
Grass spp.	Gramineae
Broad-fruited Bur-reed	Sparganium eurycarpum Engelm
Cat-tail	Typha latifolia L.
Skunk Cabbage	Lysitchitum americanum Hulten & St. John
Star Duckweed	Lemna trisulca L.
Water Lentil	Lemna minor L.
Yellow Flag	Iris pseudacorus L.

Table 1. (Continued)

Sweetbriar	Rosa eglanteria L.
Western Crabapple	Pyrus fusca Raf.
Salmonberry	Rubus spectabilis Pursh.
Thimbleberry	Rubus parviflorus Nutt.
Douglasberry	Rubus ursinus Cham. & Schlecht.
Evergreen Blackberry	Rubus laciniatus Willd.
Himalayan Blackberry	Rubus discolor Weihe & Nees
European Mountain-ash	Sorbus aucuparia L.
Spirea	Spiraea douglasii L.
Scotch Broom	Cytisus scoparius (L.) Link.
Red Clover	Trifolium pratense L.
Hairy Vetch	Vicia villosa Roth
Common Vetch	Vicia sativa var. angustifolia (L.)
Crane's-bill	Erodium cicutarium (L.) L'Her
Big-leaf Maple	Acer macrophyllum Pursh.
Vine Maple	Acer circinatum Pursh.
Jewelweed	Impatiens sp. L.
Cascara	Rhamnus purshiana DC.
Purple Loosestrife	Lythrum salicaria L.
Fireweed	Epilobium angustifolium L.
Water-milfoil	Myriophyllum brasilense Camb.
Douglas' Water Hemlock	Cicuta douglasii (DC.) Coult. & Rose
Pacific Water Parsley	Oenanthe sarmentosa Presl.
Creek Dogwood	Cornus stolonifera Michx.
Pacific Madrona	Arbutus menziesii Pursh.
Bog Laurel	Ledum groenlandicum Oeder
Ash	Fraxinus sp. L.
Morning Glory	Convolvulus sp. L.
Ground Ivy	Glecoma hederacea L.
Spearmint	Mentha spicata L.
Marsh Skull-cap	Scutellaria galericulata L.
Bittersweet	Solanum dulcamara L.
Foxglove	Digitalis purpurea L.
Yellow Monkey-flower	Mimulus guttatus DC.
American Brooklime	Veronica americana Schwein.
Bedstraw	Galium sp. L.
Black Twinberry	Lonicera involucrata (Rich) Banks
Red Elderberry	Sambucus racemosa L.
Canada Thistle	Cirsium arvense var. horridum Winn. & Grab
Water Plantain	Alisma plantago-aquatica L.
Soft Rush	Juncus effusus var. pacificus Fern & Wieg.
Saw-beak Sedge	Carex stipata Muhl. ex Willd. var. stipata

Table 2. Aquatic macrophytes of the Osoyoos Lake and Okanogan River.

Carex sp.
Ceratophyllum demersum
Chara spp.
Eleocharis palustris
Elodea canadensis
Equisetum sp.
Juncus balticus
Lemna minor
Lemna trisulca
Myriophyllum spicatum

Nuphar polysepalum
Phalaris arundinacea
Polygonum amphibium
Potamogeton berchtoldii
Potamogeton gramineus
Potamogeton illinoensis
Potamogeton natans
Potamogeton pectinatus
Ranunculus aquatilis type
Salix exigua
Scirpus acutus
Spirodela polyrhiza
Typha latifolia
Zannichellia palustris

Table 3. Systematic list of the benthic macroinvertebrates encountered in the littoral region of Lake Washington (White, 1975).

- Insecta
  - Diptera
    - Chironomidae
      - Chironominae
        - Chironomini
          - *Chironomus* sp. (nr. *plumosus*)
          - *Chironomus* sp. (nr. *viridicollis*)
          - *Endochironomus* sp.
          - *Parachironomus* sp.
          - *Stictochironomus* sp.
          - *Cryptochironomus* sp.
          - *Pseudochironomus* sp. #1
          - *Pseudochironomus* sp. #2
          - *Kiefferulus* sp.
          - *Dicrotendipes* sp.
          - *Polypedilum* sp.
        - Tanytarsini (many kinds)
      - Tanypodinae
        - Penteneurini
          - *Ablabesmyia* sp.
        - Macropelopini
          - *Procladius* sp.
        - Orthocladiinae
          - *Brillia* sp. (nr. *par*)
          - *Brillia* sp.
    - Ceratopogonidae
  - Collembola
  - Trichoptera
    - Leptoceridae
      - *Mystacides* sp.
      - *Oecetis* sp.
    - Lepidostomatidae
      - *Lepidostoma* sp.
    - Psychomyiidae
      - *Polycentropus* sp.
    - Limnophilidae
  - Lepidoptera
    - Pyralidae
      - *Paragyraetis* sp.
  - Odonata
    - Coenagrionidae
  - Ephemeroptera
    - Baetidae
      - *Callibaetis* sp.
    - Caenidae
      - *Caenis* sp.
- Annelida
  - Oligochaeta
    - Tubificidae
      - *Aulodrilus pluriseta*
      - *A. piqueti*

Table 3. (Continued)

	A. limnobius
	Limnodrilus hoffmeisteri
	L. udekemianus
	L. claparedeianus
	L. spiralis
	Ilyodrilus templetoni
	Peloscolex ferox
	Bothrioneurum vedjdovskyanum
	Branchiura sowerbyi
	Rhyacodrilus sp.
	Unidentified immature
	with capilliform setae
	without capilliform setae
Naididae	
	Nais sp.
	N. bretscheri
	Slavina appendiculata
	Uncinais uncinata
	Arcteonais lomondi
	Specaria josinae
	Dero sp.
	D. digitata
Lumbriculidae	
	Stylodrilus herringianus
Lumbricidae	
Glossoscolecidae	
Enchytraeidae	
Hirudinea	
Glossiphoniidae	
	Helobdella stagnalis
Erpobdellidae	
	Nephelopsis obscura
Piscicolidae	
	Piscicola salmositica
Crustacea	
Mysidacea	
	Neomysis awatchensis
Amphipoda	
Talitridae	
	Hyalella azteca
Decopoda	
Astacidae	
	Pacifastacus leniusculus
Isopoda	
Asellidae	
	Asellus sp.
Ostracoda	
Mollusca	
Pelecypoda	
Sphaeriidae	
	Pisidium sp.

Table 3. (Continued)

Gastropoda	
Planorbidae	
	Gyraulus deflectus
Valvatidae	
	Valvata sincera
Lymnaeidae	
	Lymnaea catescopium
Ancylidae	
	Ferrissia sp.
Acari (hydracarina)	
Coelenterata (Hydra sp.)	
Turbellaria	
Tardigrada	
Nematoda	

Table 4. List of fishes known to occur in Lake Washington.

Common Name	Species
Coho salmon	Oncorhynchus kisutch
Sockeye salmon & kokanee	Oncorhynchus nerka
Chinook salmon	Oncorhynchus tshawytscha
Coastal cutthroat trout	Salmo clarkii clarkii
Rainbow trout & steelhead	Salmo gairdneri
Dolly Varden	Salvelinus malmo
Mountain whitefish	Prosopium williamsoni
Longfin smelt	Spirinchus thaleichthys
Carp	Cyprinus carpio
Peamouth	Mylocheilus caurinus
Northern squawfish	Ptychoeheilus oregonensis
Tench	Tinca Tinca
Largescale sucker	Catastomus machrocheilus
Brown bullhead	Ictalurus nebulosus
Channel catfish	Ictalurus punctatus
Threespine stickleback	Gasterosteus aculeatus
Pumpkinseed	Lepomis gibbosus
Largemouth bass	Micropterus salmoides
Black crappie	Pomoxis nigromaculatus
Yellow perch	Perca flavescens
Sculpin	Cottus spp.

Table 5. Fish found or known to occur in/or adjacent to Lake Osoyoos-Okanogan River project areas.

Brook lamprey	Lampetra lamotlei
Pacific lamprey	Entosphenus tridentatus
White sturgeon	Acipenser transmontanus
Sockeye salmon	Oncorhynchus nerka
Coho salmon	Oncorhynchus kisutch
Chinook salmon	Oncorhynchus tshawytscha
Rainbow, steelhead trout	Salmo gairdneri
Cutthroat trout	Salmo clarki
Brown trout	Salmo trutta
Dolly Varden	Salvelinus malma
Eastern brook trout	Salvelinus fontinalis
Mountain whitefish	Prosopium williamsoni
Chiselmouth	Acrocheilus alutaceus
Carp	Cyprinus carpio
Peamouth	Mylocheilus caurinus
Northern squawfish	Ptychocheilus oregonensis
Longnose dace	Rhinichthys cataractae
Leopard dace	Rhinichthys falcatus
Redside shiner	Richardsonius balteatus
Largescale sucker	Catostomus macrocheilus
Mountain sucker	Catostomus platyrhynchus
Black bullhead	Ictalurus melas
Crappie	Pomoxis annularis
Smallmouth bass	Micropterus dolomieui
Largemouth bass	Micropterus salmoides
Yellow perch	Perca flavescens
Prickly sculpin	Cottus asper
Mettled sculpin	Cottus bairdi
Slimy sculpin	Cottus cognatus

Table 6. Aquatic and wetland birds taken from 1972 Christmas Bird Count results- Lake Washington-Sammamish and Union Bay areas.

Common loon	*Gavia immer*
Arctic loon	*Gavia artica*
Red-throated loon	*Gavia stellata*
Red-necked grebe	*Podiceps grisegina*
Horned grebe	*Podiceps aurilus*
Eared grebe	*Podiceps caspicus*
Western grebe	*Aechmophorus occidentalis*
Pied-billed grebe	*Podilymbus podiceps*
Double-crested cormorant	*Phalacrocorax auritus*
Brandt's cormorant	*Phalacrocorax penicillatus*
Pelagic cormorant	*Phalacrocorax pelagicus*
Great-blue heron	*Areda herodias*
Canada goose	*Branta canadensis*
Black duck	*Anus rubripes*
Mallard	*Anus platyrhenchus*
Gadwall	*Anus strepera*
Pintail	*Anus acuta*
Green-winged teal	*Anus carolinensis*
European wigeon	*Mareca penelope*
American wigeon	*Anus americana*
Shoveler	*Spatula clypeata*
Red head	*Aythya americana*
Ring-necked duck	*Aythya collaris*
Canvasback	*Aythya valisineria*
Greater scaup	*Aythya marila*
Lesser scaup	*Aythya affinis*
Common goldeneye	*Bucephala clangula*
Barrows goldeneye	*Bucephala islandica*
Bufflehead	*Bucephala albeola*
Oldsquaw	*Clangula hymalis*
Harlequin duck	*Histrionicus histrionicus*
White-winged scoter	*Melanitta deglandi*
Ruddy duck	*Oxyura jamaicensis*
Hooded merganser	*Lophodytes cucullatus*
Common merganser	*Mergus merganser*
Red-breasted merganser	*Mergus serrator*
Goshawk	*Accipiter gentilis*
Sharp-shinned hawk	*Accipiter striatus*
Cooper's hawk	*Accipiter cooperii*
Red-tailed hawk	*Buteo jamaicensis*
Bald eagle	*Haliaeetus leucocephalus*
Merlin (pigeon hawk)	*Falco columbarius*
Kestrel (sparrow hawk)	*Falco sparverius*
California quail	*Lophortyx californicus*
Ring-necked pheasant	*Phasianus colchicus*
Coot	*Fulica americana*
Killdeer	*Chadrius vociferus*
Black-bellied plover	*Squatorla squatorla*
Surfbird	*Aphriza virgata*

Table 6. (Continued)

Ruddy turnstone	*Arenaria interpres*
Black turnstone	*Arenaria melanocephala*
Common snipe	*Capella gallinago*
Spotted sandpiper	*Acitis macularia*
Dunlin	*Erolia alpina*
Sanderling	*Crocethia alba*
Glaucous-winged gull	*Larus glaucescens*
Western gull	*Larus occidentalis*
Herring gull	*Larus argentatus*
Thayer's gull	*Larus thayeri*
California gull	*Larus californicus*
Ring-billed gull	*Larus delawarensis*
Mew gull	*Larus canus*
Bonaparte's gull	*Larus philadephia*
Common murre	*Uria aalge*
Pigeon guillemot	*Cepphus columba*
Marbled murrelet	*Brachyramphus marmoratum*
Cassin's auklet	*Ptychoramphus aleutica*
Rhinoceros auklet	*Cerorhinca monocerata*
Belted kingfisher	*Megaceryle alcyon*
Crow	*Corvis brachyrhychos*
Long-billed marsh wren	*Telmatodytes palustris*
Bewick's wren	*Thryomanes bewickii*
Winter wren	*Troglodytes troglodytes*
Red-winged blackbird	*Agelaius phoeniceus*
Brewer's blackbird	*Euphagus cyanocephalus*
Song sparrow	*Melospiza melodia*
Fox sparrow	*Passerella iliaca*

Table 7. Birds found or known to occur in/or adjacent to the Osoyoos Lake-Okanogan River project areas.

Swainson's hawk	Buteo swainsoni
Sharp-shinned hawk	Accipiter striatus
Rough-legged hawk	Buteo lagopus
Redtailed hawk	Buteo jamaicensis
Marsh hawk	Circus cyaneus
Sparrow hawk	Falco sparverius
Prairie falcon	Falco mexicanus
Golden eagle	Aquila chrysaetos
Blue grouse	Dendragapus obscurus
Ruffed grouse	Bonasa umbellus
Turkey	Meleagris gallopavo
Mourning dove	Zenaidura macroura
Screech owl	Otus asio
Great horned owl	Bubo virginianus
Pygmy owl	Glaucidium gnoma
Saw-whet owl	Aegolius acadicus
Common nighthawk	Chordeiles minor
Vaux's swift	Chaetura vauxi
Rufous hummingbird	Selasphorus rufus
Calliope hummingbird	Stellula calliope
Common flicker	Colaptes auratus
Pileated woodpecker	Dryocopus pileatus
Olive-sided flycatcher	Nuttallornis borealis
Gray jay	Perisoreus canadensis
Steller's jay	Cyanocitta stelleri
Black-billed magpie	Pica pica
Common raven	Corvus corax
Clark's nutcracker	Nucifraga columbiana
California quail	Lophortyx californicus
Ring-necked pheasant	Phasianus colchicus
Hungarian partridge	Perdix perdix
Chukar	Alectoris graeca
Black-capped chickadee	Parus atricapillus
Mountain chickadee	Parus gambeli
Bushtit	Psaltriparus minimus
Brown creeper	Certhia familiaris
Long-billed marsh wren	Telmatodytes palustris
House wren	Troglodytes aedon
Rock wren	Salpinctes obsoletus
Hermit thrush	Hylocichla guttata
Townsend's warbler	Dendroica townsendi
Wilson's warbler	Wilsonia pusilla
Western tanager	Piranga ludoviciana
Pine grosbeak	Pinicola enucleator
Lazuli bunting	Passerina amoena
Cassin's finch	Carpodacus cassinii
House finch	Carpodacus mexicanus
Hammond's flycatcher	Empidonax hammondii
Western wood pewee	Contopus cordidulus

Table 7. (Continued)

Pine siskin	Spinus pinus
Red crossbill	Loxia curvirostra
Canvasback	Aythya valisineria
Green-winged teal	Anas crecca
Greater scaup	Aythya marila
Eared grebe	Podiceps nigricullis
Pied-billed grebe	Podilymbus podiceps
Whistling swan	Olor columbianus
Canada goose	Branta canadensis
Common goldeneye	Bucephala clangula
Mallard	Anas platyrhenchus
Bufflehead	Bucephala albeola
Pintail	Anas acuta
Ruddy duck	Oxyura jamaicensis
Wood duck	Aix sponsa
Common merganser	Mergus merganser
Hooded merganser	Lophodytes cucullatus
Red-breasted merganser	Mergus serrator
American wigeon	Anas americana
Redhead	Aythya americana
Turkey vulture	Cathartes aura
Sharptailed grouse	Pedioecetes phasianellus
Great blue heron	Ardea herodias
Virginia rail	Rallus limicola
Sora	Porzana carolina
Sandhill crane	Grus canadensis
American coot	Fulica americana
Sanderling	Crocethia alba
Herring gull	Larus argentatus
Ring-billed gull	Larus delawarensis
Black tern	Chlidonias niger
American avocet	Recurvirostra americana
Wilson's phalarope	Steganopus tricolor
Rock dove	Columba livia
Long-eared owl	Asio otus
Short-eared owl	Asio flammeus
Burrowing owl	Speotyto cunicularia
Great gray owl	Strix nebulosa
Belted kingfisher	Megaceryle alcyon
Lewis' woodpecker	Asyndesmus lewis
Yellow-bellied sapsucker	Sphyrapicus varius
Hairy woodpecker	Dendrocopos villosus
Downy woodpecker	Dendrocopos pubescens
Northern three-toed woodpecker	Picoides tridactylus
Eastern kingbird	Tyrannus tyrannus
Western kingbird	Tyrannus verticalis
Say's phoebe	Sayornis saya
Traill's flycatcher	Empidonax traillii
Golden-crowned kinglet	Regulus satrapa
Ruby-crowned kinglet	Regulus calendula

Table 7. (Continued)

Horned lark	Eremophila alpestris
Violet-green swallow	Tachycineta thalassina
Barn swallow	Hirundo rustica
Cliff swallow	Petrochelidon pyrrhonota
Bank swallow	Riparia riparia
Tree swallow	Iridoprocne bicolor
Common crow	Corvus brachyrhynchos
White-breasted nuthatch	Sitta carolinensis
Red-breasted nuthatch	Sitta canadensis
Pygmy nuthatch	Sitta pygmaea
Robin	Turdus migratorius
Sage thrasher	Oreoscoptes montanus
Western bluebird	Sialia maxicana
Mountain bluebird	Sialia currucoides
Bohemian waxwing	Bombycilla garrulus
Northern shrike	Lanius excubitor
Loggerhead shrike	Lanius ludovicianus
Starling	Sturnus vulgaris
Solitary vireo	Vireo solitarius
Red-eyed vireo	Vireo olivaceus
Warbling vireo	Vireo gilvus
Orange-crowned warbler	Vermivora celata
Yellow warbler	Dendroica petechia
Yellow-rumped warbler	Dendroica coronata
Common yellowthroat	Geothlypis trichas
Nashville warbler	Vermivora ruficapilla
MacGillivray's warbler	Oporornis tolmiei
Yellow breasted chat	Icteria virens
American redstart	Stophaga ruticilla
House sparrow	Passer domesticus
Boblink	Dolichonyx oryzivorus
Western meadowlark	Sturnella neglecta
Red-winged blackbird	Agelaius phoeniceus
Yellow-headed blackbird	Xanthocephalus xanthocephalus
Brewer's blackbird	Euphagus cyanocephelus
Brown-headed cowbird	Molothrus ater
Northern oriole	Icterus galbula
Black-headed grosbeak	Pheucticus melanocephalus
Evening grusbeak	Hesperiphona vespertina
Purple finch	Carpodacus purpureus
American goldfinch	Spinus tristis
Rufous-sided towhee	Pipilo erythrophthalmus
Savannah sparrow	Passerculus sandwichensis
Vesper sparrow	Povecetes gramineus
Lark sparrow	Chondestes grammacus
Dark-eyed junco	Junco hyemalis
White-crowned sparrow	Zonotrichia leucophrys
Brewer's sparrow	Spizella breweri
Song sparrow	Melospiza melodia
Grasshopper sparrow	Ammodramus savannarum

Table 8. Mammals found or known to occur in/or adjacent to the Osoyoos Lake and Okanogan River project areas.

Northern flying squirrel	*Glaucomys sabrinus*
Northern pocket gopher	*Thomomys talpoides*
Deer mouse	*Peromyscus maniculatus*
Long-tailed meadow mouse	*Microtus longicaudus*
Porcupine	*Erethizon dorsatum*
Beaver	*Castor canadensis*
Muskrat	*Ondatra sibethicus*
Mink	*Mustela vison*
Striped skunk	*Mephitis mephitis*
Raccoon	*Procyon lotor*
Marten	*Martes americana*
River otter	*Lutra canadensis*
Long-tailed weasel	*Mustela frenata*
Badger	*Taxidea taxus*
Little brown myotis	*Myotis lucifugus*
California myotis	*Myotis californicus*
Yuma myotis	*Myotis yumanensis*
Silvery-haired bat	*Lasionycteris noctivagans*
Big brown bat	*Eptesicus fuscus*
Nutria	*Myocaster coypus bonariensis*

Table 9. Amphibians and reptiles found or known to occur in/or adjacent to Osoyoos Lake-Okanogan River project areas.

Long-toed salamander	Ambystoma macrodactylum
Tiger salamander	Ambystoma tigrinum
Western spadefoot	Scaphiopus hammondi
Western toad	Bufo boreas
Pacific tree frog	Hyla regilla
Spotted frog	Rana pretiosa
Painted turtle	Chrysemys picta
Western skink	Eumeces skiltonianus
Northern alligator lizard	Gerrhonotus coreuleus
Common garter snake	Thamnophis sirtalis
Western garter snake	Thamnophis elegans
Rubber boa	Charina bottae
Tailed frog	Ascaphus truei
Bull frog	Rana catesbeiana
Rough-skinned newt	Taricha granulosa granulosa

appendix e

DRAFT COOPERATIVE AGREEMENT BETWEEN SEATTLE DISTRICT AND WASHINGTON STATE DEPARTMENT OF ECOLOGY

COOPERATIVE AGREEMENT

BETWEEN THE

U.S. ARMY CORPS OF ENGINEERS

AND THE

STATE OF WASHINGTON

Address: State of Washington
Department of Ecology
Olympia, Washington

Purpose: Prevention and Control of
Eurasian Watermilfoil

Payment to be made: Disbursing Office
Seattle District Corps of Engineers
Seattle, Washington

COOPERATIVE AGREEMENT

BETWEEN THE
U.S. ARMY CORPS OF ENGINEERS
AND THE
STATE OF WASHINGTON

I. PURPOSE.

The purpose of this Cooperative Agreement is to specify the arrangements under which the U.S. Army Corps of Engineers and the State of Washington will cooperate to implement a program for the prevention and control of Eurasian watermilfoil in the State of Washington.

II. PARTIES.

The parties to the Cooperative Agreement are the U.S. Army Corps of Engineers represented by the District Engineer, Seattle District (hereinafter "CORPS") and the State of Washington, Department of Ecology (hereinafter "STATE").

III. AUTHORITY.

This Cooperative Agreement is executed by the parties hereto pursuant to Section 302 of Public Law 89-298 (79 Stat. 1092).

IV. COOPERATION.

(A) Pursuant to Public Law 89-298, the STATE agrees to provide the items of local cooperation required as a condition to Corps assistance in the establishment of a prevention and control program for Eurasian watermilfoil in the State of Washington. Specifically, the STATE agrees to hold and save the United States free from claims that may occur from the prevention and control operations carried out under this Agreement and to bear 30 per centum of the costs of the program.

(B) All operations carried out, or caused to be carried out, by the STATE pursuant to this Cooperative Agreement shall conform as a minimum to the requirements in Appendix A, Minimum Work Requirements which is attached and a part of this Cooperative Agreement. The STATE shall, within 60 days of the effective date of this Cooperative Agreement, submit for approval a Program Management Plan which demonstrates how these requirements will be met by the STATE in operation and management of the program.

(C) Initial Government-Furnished material is shown by Appendix B; this may be changed by agreement of both Parties.

(D) The STATE, in cooperation with the CORPS, shall identify and develop the tasks to be accomplished to satisfy the purposes of this Cooperative Agreement and shall compile requirements and scopes of work, which will be attached as Appendix C, Annual Budgeting Work Plan, outlining such tasks to be performed by the STATE. This process shall be commenced within thirty days of the effective date of this Agreement and repeated annually thereafter at the beginning of the third quarter each Federal fiscal year. In addition to identification and development of tasks this annual review will consider, among other things, amendments which the parties may consider appropriate to be made to this Agreement affecting future operations. The following priorities shall govern the identification and development of the scope of work and tasks to be accomplished:

(1) Prevention Operations (First Priority).

(a) Identification and treatment of water bodies where the detection and treatment of Eurasian watermilfoil will prevent its spread to navigable waters of the United States within the State of Washington.

(b) Informing and educating citizens of the State of Washington regarding the presence of Eurasian watermilfoil, potential problems posed by the plant, and measures to prevent its spread.

(2) Control Operations (Second Priority).

(a) Treatment of public-use areas (such as waterfront parks, swimming beaches, or boat launch ramps) located on navigable waters of the United States within the State of Washington.

(b) Public boating areas in navigable waters of the United States within the State of Washington, such as connecting channels to open water.

(E) The STATE shall, after receiving approval for work in Appendix C, develop a detailed statement of work to become Appendix D for each particular task which will be approved by the Corps before work is started. These shall contain at a minimum:

(1) A full and complete detailed description of the nature of the work to be performed.

(2) The type of information, data, report, or other product, if any, to be developed by the STATE in performing the task.

(3) The date when the task will be initiated, the date by which the task will be completed, and any dates for submission of reports.

(4) The total applicable costs involved for performing the task which will be paid by the CORPS to the STATE.

V. DISPUTES.

Any dispute arising under this Cooperative Agreement shall be decided by the CORPS, Seattle District Engineer, who shall reduce his decision to writing and mail or otherwise furnish a copy thereof to the STATE. The decision of the Seattle District Engineer shall be final and conclusive unless, within thirty days from the date of receipt of such copy, the STATE mails or otherwise furnishes to the CORPS a written appeal addressed to the CORPS, North Pacific Division Engineer. The decision of the Division Engineer shall be final and conclusive. In connection with any appeal proceeding under this clause, the STATE shall be afforded an opportunity to be heard and offer evidence in support of its appeal. Pending final decision of a dispute hereunder, the STATE shall proceed diligently with the performance of all tasks identified and agreed to be undertaken pursuant to this Cooperative Agreement and in accordance with the decision of the District Engineer.

VI. REIMBURSEMENT.

Subject to the availability of funds the CORPS will reimburse the STATE for 70 percent of the total cost of performing the approved tasks identified, assigned and undertaken pursuant to this Cooperative Agreement minus an allowance for the State's 30 percent share of the Corps' costs applicable to administering its cooperative program. Reimbursement will be based on a Cost Allocation Plan prepare by the STATE and approved by the Corps which will be attached as Appendix E and will be the means for identifying, accumulating, and distributing allowable costs under this agreement. No repayment credit will be allowed the STATE toward its 30 percent share of the cost of this program for expenditures financed by, involving, or consisting of funds received from any other Federal agency. The CORPS will reimburse the STATE not more frequently than monthly, nor less than quarterly, upon receipt of properly certified invoices in triplicate. So far as practicable, the STATE shall keep separate records on all items of expense which will constitute the cost accounting records from which the invoices will be prepared. These records will provide sufficient detail to permit complete audit of the 70/30 cost sharing.

VII. RELATIONSHIP OF PARTIES.

The parties to this Cooperative Agreement act in their independent capacities in the performance of their respective functions under it, and neither party is to be considered the officer, agent or employee of the other.

VIII. DURATION OF COOPERATIVE AGREEMENT.

(A) This Cooperative Agreement will continue in full force and effect for the duration of the aquatic plant control program unless terminated earlier by either party hereto on providing ninety (90) days' advance written notice to the other.

(B) The CORPS shall have the option of directing the STATE to cease performance of any task and the CORPS shall not be liable for any costs associated with continued performance of a task incurred after receipt by the STATE of a notice to cease performance.

(C) It is understood and agreed that termination of this Agreement by either party for whatever reason shall not end the obligation of the STATE to hold and save the United States Government free from claims as provided in Article IV of this Cooperative Agreement.

IX. PROJECT OFFICERS REPRESENTING THE CORPS AND THE STATE.

(A) CORPS: _____

_____

_____

ALTERNATES: _____

_____

(B) STATE: _____

_____

ALTERNATES: _____

_____

Project Officers and Alternates may be changed by either party upon written notice to the other party.

X. EFFECTIVE DATE.

This Cooperative Agreement shall take effect upon the date of execution by the District Engineer, Seattle District.

STATE OF WASHINGTON:

CORPS OF ENGINEERS:

LEON K. MORASKI
Colonel, Corps of Engineers
District Engineer

Date: _____

Attached Appendices:	Page	
A - Minimum Work Requirements	2	Article (B)
B - Government-Furnished Materials	2	Article 4(C)
C - Annual Budgeting Work Plan	2	Article 4(D)
D - Detailed Statement of Work	2	Article 4(E)
E - Cost Allocation Plan	3	Article 6

APPENDIX A

MINIMUM WORK REQUIREMENTS

1. Methods of Prevention and Control. Treatment methods which are approved for use in prevention and control operations are:

- Prevention. Rotovating, hand removal, suction dredging, fragment barriers, or the herbicide 2,4-D.

- Control. Mechanical harvesting, fiberglass bottom screens, or the herbicides 2,4-D, endothall (dipotassium salt), diquat, and dichlobenil.

2. Work Plan.

a. The state shall prepare and submit for review and approval, a work plan which (i) designates the estimated nature and areal extent of prevention and control operations to be performed during the period of service and (ii) identifies local sponsor.

b. The state shall prepare and submit for review and approval, at least 120 days prior to the end of the Federal fiscal year, a tentative plan for work to be performed during the coming year.

3. Prevention and Control by Chemical Methods.

a. Plans and specifications for prevention and control operations by chemicals shall be prepared and submitted for review and approval prior to the commencement of such work.

b. Only materials specifically approved by the Corps of Engineers will be used. Unless otherwise specifically approved by the Corps of Engineers, the herbicides used shall be only those approved by and registered for use by the Environmental Protection Agency (EPA), and the herbicides shall only be used in a manner consistent with their intended use and label instructions; i.e., specific target plant, environmental setting, dosage rate, etc.

4. Prevention and Control by Mechanical Methods.

a. Plans and specifications for prevention and control operations by mechanical means shall be prepared and submitted for review and approval prior to the commencement of such work.

b. Mechanical devices may be used to the extent they are approved by the Corps of Engineers. They may be used for eradication of small, isolated colonies of Eurasian watermilfoil or to control established populations.

5. Public Notification. The state will inform residents adjacent to treatment areas and potential users of the areas of the nature of the treatment and any restrictions necessary.

a. For chemical treatment operations, chase boats, shore patrols and signing will be utilized. Following chemical treatment signs will be maintained along the perimeter of the treated areas advising residents and potential users of the nature of the treatment and any restrictions. When results of the monitoring indicate concentrations have reached established acceptable intake levels in accordance with World Health Organization criteria, signs will be removed.

b. For mechanical treatment operations, chase boats and shore patrols will be utilized.

The Public Affairs Office of the Corps of Engineers, Department of Ecology, and the local government will be advised of the schedule of treatment operations.

6. Supervision and Inspection.

a. Work will be conducted generally in accordance with drawings and directives contained within the design memorandum provided by the Corps of Engineers. All operations will be subject to inspection to insure that the work is accomplished within the limits of the recommended program and the results obtained are satisfactory.

b. Supervision of field operations will be carried out by representatives of the state or designated representative to determine that all provisions are met in a satisfactory manner.

7. Monitoring and Evaluation. Monitoring and evaluation is necessary to determine the overall results of the aquatic plant management program and the effectiveness of controlling existing populations of milfoil and preventing its spread to uninfested navigable waters of Washington State. Monitoring is also necessary because of public concern over the use of chemicals for milfoil prevention and control.

a. The state will be responsible for evaluating treatment site selections to insure that:

- interested individuals, groups, and agencies are involved in the selection process;

- site selection is based on giving prevention measures a higher priority than control measures;

- sites are not located within authorized Federal projects;

- the site selected is in a navigable water of the United States and is infested to a degree which impairs recreational usage, navigation, flood control, drainage, agriculture, fish and wildlife, public health, hydropower, or related purposes, or in any other water body which may result in the infestation of navigable water;

- treatment of the proposed site will not result in an unacceptable impact to the environment; and

- treatment methods selected by the local sponsors are one or a combination of those recommended by the Corps of Engineers.

b. The state will monitor and evaluate the cost and effectiveness of mechanical treatment measures. The effectiveness of mechanical control treatment measures will be monitored by comparison of the time which the treated area remains free from detrimental effects of milfoil with a standard time period range for that particular mechanical treatment method.

c. The state will insure that the applicator applying chemicals for the treatment of milfoil is certified by all required local, state, and Federal licensing agencies. The cost of a unit of area treated will be monitored by comparison with a standard cost range for a unit of treatment area. At selected sites, the state will monitor milfoil treatment to determine whether the actual concentrations of herbicides in the water, following milfoil treatment, are compatible with the label descriptions specifying persistence. Samples will be taken before, during, and after application. The degree of drift of the herbicides will also be monitored where necessary. The effectiveness of chemical treatment measures will be monitored, including the percentage of root kill resulting from treatment and the selectivity of the plant kill.

d. In the event that monitoring detects greater concentrations of a herbicide in a water body than specified on a manufacturer's label, site-specific information relative to the herbicide treatment (i.e., application rate, persistence, etc.) will be examined to determine whether modifications to future treatment measures are necessary. Also, data needs at the treatment site are to be evaluated to determine whether modifications in the scope of future monitoring measures would be necessary in conjunction with subsequent herbicide treatments.

e. The state will monitor and evaluate public awareness of treatment methods used through the use of interviews, questionnaires, and coordination with the public affairs offices of the Corps of Engineers' Seattle District.

f. The state will periodically make projections of future milfoil growth and compare these projections with actual infestation levels.

g. The state will provide the results of the monitoring and evaluation program to the Corps of Engineers and also make the results available to the public on request.

8. Report of Operations. The work accomplished by the state or designated representative will be reported on a standard form to be developed by the state. Reports will be forwarded on the 15th day of each month to the Corps of Engineers to cover work accomplished during the preceding month.

9. Procurement. Materials and supplies used by the state or designated representative on that portion of the work assigned to it will be purchased by the state or designated representative. Accepted methods of procurement will be followed and current inventories maintained. Procurement of chemicals (by scientific brand or common name), other than those specified in the design memorandum for field operations, shall be approved by the Corps of Engineers prior to purchase. Fiberglass bottom screens purchased for the treatment of milfoil will become the property of the state or his designated subcontractor.

10. Plant and Equipment. Where the state or designated representative furnishes its own plant and equipment to perform that portion of the work coming under the 30 percent local contribution agreement, the initial purchase cost of this plant and equipment shall not be included as an integral part of the 30 percent local contribution. However, an equitable rental charge for the plant and equipment based on the initial cost of the item, anticipated economic life, reasonable maintenance charges, and amortization costs may be included in the 30 percent local contribution. This same rental arrangement shall be applied to any additional work assigned. Rental charges will be made on a daily use basis and will be applicable to only those items approved for the work. Plant furnished by the state may be increased or decreased by agreement to meet existing needs of the work.

11. Safety. Safety requirements as a minimum will be in accordance with Corps of Engineers Manual EM 385-1-1, dated 1 June 1977, entitled "General Safety Requirements."

RECOMMENDED SAFETY MEASURES
IN HANDLING OF HERBICIDES

1. The use of herbicides may result in exposure of personnel and precautions must be taken to keep worker exposure to a minimum. Appropriate medical surveillance, consisting of preplacement and periodic examinations, must be provided to individuals applying herbicides.

a. Preplacement Examination.

- Personal, occupational, and medical histories, paying particular attention to respiratory, gastrointestinal, dermatological, and neurological systems.

- Physical examination, emphasizing the above systems.

- Evaluation of the ability to use respiratory protective equipment. This should include a chest x-ray and pulmonary function testing. The latter should, at a minimum, consist of determination of forced vital capacity (FVC) and forced expiratory volume at one second (FEV-1).

- Laboratory tests, including a complete blood count with differential white cell count; liver function tests such as serum glutamic oxalacetic transaminase (SGOT), serum glutamic pyruvic transaminase (SGPT), lactic dehydrogenase (LDW), serum bilirubin; and renal function tests such as complete urinalysis, serum creatinine, and blood urea nitrogen (BUN).

b. Periodic Examination.

- Of similar scope to the preplacement examination, with the exception of the x-ray, which should not be repeated.

- An annual examination is recommended.

- If chemical treatment is seasonal, periodic examination should be scheduled at the end or near the termination of the treatment season.

2. Read the label on each container before using the contents. The manufacturers are required by law to list recommendations and precautions.

3. Weather conditions are important. Application of herbicides shall be controlled at all times. No application will be attempted when conditions would make operations difficult.

4. *Smoking is not permitted* while herbicides are being handled.

5. All herbicides must be handled in well ventilated areas to minimize inhalation of toxic vapors.

6. Shower and eye wash facilities must be near herbicide mixing areas.

7. Any contamination of skin, particularly with liquid concentrations or solutions, must be immediately washed off with detergent and water.

8. Protective clothing is used in conjunction with respiratory protective devices to prevent skin contact and inhalation of herbicides. Recommended articles of protective clothing are rubber gloves, rubber aprons, coveralls, chemical splash goggles, safety shoes, and hard hats. A lightweight water- and chemical-resistant, throw-away type protective clothing that is impervious to herbicides is now available. In warm geographical areas, this type of lightweight protective clothing would be beneficial in reducing physical stress to applicators. Additional protection is afforded by protective skin cream.

9. Clothing contaminated by spillage must be removed immediately and thoroughly laundered before wearing. Special care is required to prevent contamination of the inside of gloves.

10. Approved respirators must be worn while herbicides are being mixed and when liquids are being handled or sprayed. Care should be exercised when selecting the respirator type to insure that it is designated specifically for the substance to be used. Each respirator must be labeled and approved by the U.S. Department of Agriculture or National Institute for Occupational Safety and Health. Filters or canisters must be changed after 8 hours use and more often if odor of the herbicide is detected. Always have extra cartridges available.

11. Herbicide Storage, Mixing, and Formulation Facilities.

a. All herbicides must be stored in a dry, well ventilated, separate room, building, or covered area not accessible to unauthorized personnel or the public and placed under lock and key.

b. Identification signs should be placed on rooms, buildings, and fences to advise of the contents and warn of their hazardous nature.

c. Where applicable, the outside of each storage area should be labeled with "Danger," "Poison," and "Herbicide Storage" signs.

d. Fire extinguishers must be installed near the door of material storage rooms. Diluted, oil-based herbicides are flammable and must be stored separately from other materials.

e. All herbicide storage, mixing, and formulation areas must have adequate ventilation in order to reduce inhalation of toxic vapors. Spark-proof lighting fixtures should be installed in closed storage areas to eliminate ignition hazards.

12. Empty herbicide containers must be disposed of properly. Do not burn them. When herbicides volatilize, the resulting vapors may be poisonous to humans, and they may damage nearby plants, crops, or shrubbery; also, herbicides containing chlorates may be a serious fire hazard when heated.

13. Glass herbicide containers should be disposed of by breaking. Chop holes in top, bottom, and sides of metal containers, or crush them so they cannot collect water or be reused. After breaking or puncturing them, bury the containers at least 18 inches deep in an isolated area provided for this purpose, away from water supplies or high-water tables. Records to locate such buried herbicides within the landfill site should be maintained. Post warning signs.

14. Safety programs developed for the safe handling and mixing of chemicals should be coordinated with the Corps of Engineers prior to implementation.

APPENDIX B
GOVERNMENT-FURNISHED MATERIAL

1. The Corps of Engineers will furnish to the state the following data for information, guidance, and use:

a. Design Memorandum, State of Washington Aquatic Plant Management Program, Seattle District, U.S. Army Corps of Engineers, dated October 1979.

b. Final Environmental Impact Statement, State of Washington Aquatic Plant Management Program, Seattle District, U.S. Army Corps of Engineers, dated October 1979.

c. Department of the Army, Engineering Regulation (ER) 1130-2-412, Project Operation, Aquatic Plant Control Program, RCS-DAEN-CWO-51, dated 28 May 1976.

d. Section 302, Public Law 89-298 (79 Stat. 1092), River and Harbors Act of 1965, as amended.

e. Department of the Army, Engineering Manual (EM) 385-1-1, General Safety Requirements, dated 1 June 1977.

APPENDIX C
ANNUAL BUDGETING WORK PLAN

APPENDIX D
DETAILED STATEMENT OF WORK

APPENDIX E[1]/
COST ALLOCATION PLAN

The above Appendices to be cooperatively developed
by State and Corps and Approved by Corps.

1/Will be based on Appendices A through D and using Sec 302 of PL 89-298 and ER 1130-2-412 as guidelines.